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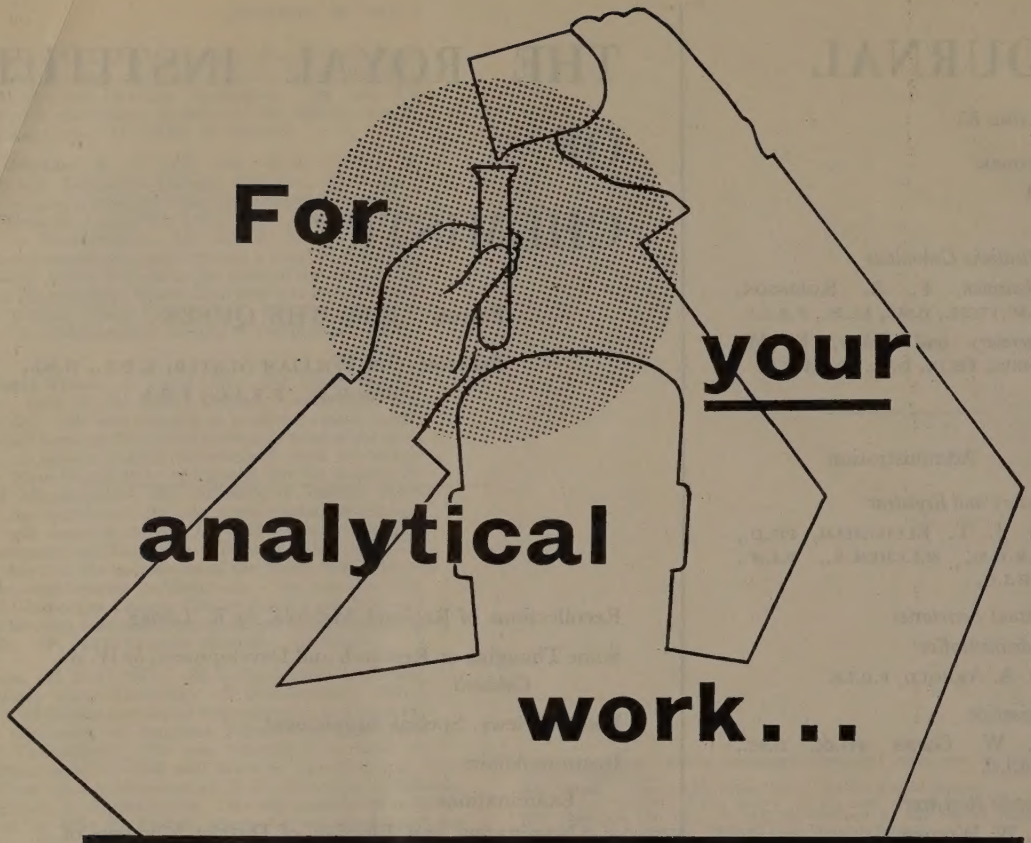

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RECOLLECTIONS OF RAPHAEL MELDOLA

By RUDOLF LESSING, C.B.E., PH.D., M.I.CHEM.E., F.INST.F.,
HON.M.INST.GAS E., F.INST.PET., F.R.I.C.

Soon after I came to London in 1903 I had the good fortune to be introduced to Professor Meldola by one of Mrs Meldola's sisters, a friend of some relatives of mine. Having worked for a time at Owens College, Manchester, with W. H. Perkin, I had then become research chemist at the Beckton tar works of the Gas Light and Coke Company. I doubt whether my limited knowledge of coal tar, or the array of brilliant teachers (Adolf von Baeyer, Emil Fischer, Carl Graebe, my chief, Richard Willstaetter, Thiele, Koenigs, Konrad Roentgen, van t'Hoff, Paul Groth and others) under whom I had studied, was the cause of the great kindness Meldola extended to me. I rather think that he was impelled by nature to hold out a friendly, helping hand to a struggling young chemist, whoever he was.

One always felt genuinely welcome at 6 Brunswick Square. Professor and Mrs (Ella) Meldola kept open house, and their 'At Homes' were gatherings of interesting people, equal to any 'salon' of days gone by. One met not only scientists, but writers, journalists, artists, actors and actresses, politicians—a whole cross-section of the intelligentsia of the time. At these functions Mrs Meldola was ably and loyally supported by her sisters, Mrs Somerville, wife of a medico, and Mrs Cohn, one of whose sons—differing in make-up from his uncle—became a stockbroker and racehorse owner and married the daughter of Horatio Bottomley.

Meldola's sound judgment on many subjects, his incisive talk and his sense of humour explain his great popularity, which was unimpaired by his frail frame and a by-no-means prepossessing countenance (*vide* his portrait in the Council Room of the Institute.

Meldola's wide circle of friends and acquaintances arose from his very diversified interests, all actively pursued throughout his life. There is no need to enlarge on his eminence as a chemist. 'Meldola Blue' will always be remembered. He also was a keen naturalist, first President of the Essex Field Club. He was closely associated with Charles Darwin who was his proposer for the Fellowship of the Royal Society. He took part in the observation of the total eclipse in the Nicobar Islands in 1875, unfortunately spoiled by thick clouds. He carried out researches in photography and was interested in archaeology. Above all he was a successful teacher of chemistry, a fair number of his students rising to high academic rank, among them Sir Gilbert Morgan, Sir William Pope, Sir Martin O. Forster and others.

Meldola was President of the Institute of Chemistry when war broke out in 1914. He had again and again called attention to the shortcomings of British chemical industry. One of his first acts was to preside on 22 September 1914 over a joint meeting of the Councils of the Institute and the Society of Public Analysts, which I attended as one of the Honorary Secretaries of the S.P.A., to consider the supply of laboratory equipment and reagents, for which we had been largely dependent on Germany. He took on the chairmanship of the reagents committee, Professor (later Sir) Herbert Jackson of Kings College acting as chairman of a committee which organized supplies of glass, porcelain and filter paper. Both committees had the satisfaction of having put the respective manufactures on a sound and lasting footing.

Meldola made me join the Alliance Franco-Britannique in which he took an active interest, stimulated by his friendship with French chemists and his love for France. It was also he who proposed me as a member of the Society of Maccabaeans, to which and to the Royal Institute of Chemistry the Meldola Medal and the Meldola Society owe their existence.

My final recollection of Raphael Meldola is paying him the last honour when he was buried at Hendon on 18 November 1915, with the impressive ritual of the Spanish and Portuguese Jews' Congregation, of which he had been an active member.

Soon after his death a volume of reminiscences (*Raphael Meldola*, Williams & Norgate, 1916) by his most intimate friends, colleagues and pupils was published with a foreword by Lord Moulton and containing a full account of his works. It is a book which may be appropriately recommended to all Meldola Medallists.

In conclusion I may be allowed a word of appreciation of 'The Maccabaeans' who conceived the idea of commemorating Raphael Meldola in the particular manner adopted. At the same time a tribute must be paid to the Committee of the Royal Institute of Chemistry for their success in adjudicating the award (*see* also p. 376).

Looking at the list of Meldola Medallists (published in the *Register* of the Royal Institute of Chemistry) one cannot but admire the perspicacity with which the selectors have contrived to 'pick winners' from applicants under the age of 30. Sixteen of the first nineteen medallists are Fellows of the Royal Society, one of them was lately its President, and two have become Nobel Laureates. This wonderful record strongly justifies the conclusion that the award of the Meldola Medal is a stepping-stone to the attainment of the highest honours science can bestow, a fitting memorial to the man whose name it bears.

SOME THOUGHTS ON RESEARCH AND DEVELOPMENT*

By W. A. CALDWELL, B.SC., PH.D., F.R.I.C.

May I first of all make clear two things:

(1) My remarks apply primarily to industrial research for I have had little experience of the academic field;

(2) What I am about to say represents my own personal views and not necessarily those of the company that employs me.

Why does a big industrial company undertake research and development? Before answering this question let us consider another. What is the aim of such a company? I have heard it defined as 'the promotion, in the long term, of the interests of the stockholders,' or, if you would like it put more bluntly, 'to make as much money as possible over a period of years.' The emphasis on the prolonged time period in both these definitions is, of course, important. It implies that good and fair conditions of employment are desirable because they will attract and hold better employees and in the long term more than pay for themselves. It implies that financial policy can be considered not merely in the light of immediate results but over a period of years. It implies, and this is important from my point of view, that the company concerned is prepared to back even long-term research and development—if it is likely to pay off in the end.

And that, if I may suggest it, is the reason why we in industry should do research and development—because it will make money.

Now 'research and development' covers a very wide range of activities—you can consider it as a continuous spectrum ranging from pure and fundamental research through speculative research, applied research and development to short-term research and development on day-to-day problems. I would like to consider some of these separately.

First of all, fundamental research. Traditionally this is the concern of the universities and certain colleges. Should industry concern itself with it and if so, how much? My view is that industry must support academic research to a certain extent. This can be argued on moral grounds—we in industry are continuously drawing from the pool of knowledge created by fundamental research. It is only right that something should go back. Even from the narrower view of self-interest, however, support of the universities leads to closer liaison with the teaching staffs thereof and aids the problem of recruitment. These views are in fact put into practice by quite a number of large firms who maintain research scholarships in the universities and in addition give grants for maintenance of research students and purchase of equipment.

Should we in industry carry out fundamental research ourselves? Here my answer would be a qualified 'yes.' Qualified, in the sense that only that amount of money be spent which a company feels can be maintained over good years and bad years and thus preserve the stability and continuity that are so desirable in this type of work. Qualified, in the sense that the investigation should be carried out in a field where the results may provide a background of knowledge for more direct work. For example, it would be reasonable in my opinion that we in the Nobel Division of I.C.I. should carry out fundamental work on detonation phenomena. It would not, in my opinion, be reasonable for us to do fundamental work on, say, steroids. The chances of any results arising from such work which would have a bearing on our own problems are too remote.

What do we hope to get out of fundamental work? There are a number of things. There is the background knowledge referred to above, but apart from this it adds to the reputation of a research and development department, and it provides a reservoir of staff able to advise on the most difficult problems and techniques that may arise in applied work.

So my vote would be for a modest modicum of fundamental work in a research and development department of any size. The field and the amount of money available over a period of years should be defined, and apart from that there should be no detailed management control.

This, however, does not mean that we should set up a cosy little team of fundamental workers and forget all about them. The vitally important thing is that there should be someone who can understand their work and who at the same time is aware of the practical problems awaiting solution in the company. You cannot expect the fundamental researchers to be responsible for seeing that something in their work has a practical slant. Someone else has to do that, and if it is not done, then a great deal of the value to the company of the fundamental work may be lost. This has happened. There is a process now being developed in Germany which represents a major technical advance. The essential basic reaction was discovered some years ago in the

* Retiring Chairman's Address to the Glasgow and West of Scotland Section, 10 March, 1961.

fundamental work of another company and was never exploited.

Let us now move on to speculative research. The essential difference between fundamental and speculative research is that the one pursues knowledge for its own sake, whereas the other is very definitely searching for something that will be profitable, albeit in the long term. It is, in my opinion, definitely the business of industry and not of the universities.

Now, how speculative can you get? The transmutation of base to noble metals is frequently considered to be rather a doubtful prospect, but then so was the manufacture of diamonds and this is now an industrial process. My own feeling is that it is worth trying anything that is not violently opposed to well-established theory. I realize that even this limitation may exclude some valuable work, since, after all, established theories are frequently overthrown—but it is just a question of betting on the chances of something coming out of the research and matching them against the resources available.

There are two main ways of carrying out speculative research. The first, which is common in the organic field, is to pursue the leads given by a reaction or series of reactions and make a number of compounds. This is a particularly valuable method of approach in the early stages of work in any given field, and very often a large number of interesting compounds can be prepared. Then comes the problem of what to do with them. This situation is, I think, well illustrated in the organometallic work carried out in my department over the past few years. We are now expert in this field and have a good understanding of many of the reactions. We have not in fact prepared any compounds which have so far been shown to have major commercial applications outside of the company. Indeed I think it would be fair to say that the chief results which have so far come out of this work are:

(1) A process improvement for silicones, which was not included in the original intention, and

(2) A product which, quite unexpectedly, has been found to have a specific beneficial effect as an additive to silicone rubbers.

This leads me to a very important point which I shall refer to several times, and that is the unexpectedness of research. Again and again the important thing arising from a piece of research is not the particular idea that was originally pursued. It is something else that has come up by accident, perhaps by good luck, perhaps by inspiration, and it is the mark of the good researcher and the good supervisor that this unexpected 'nugget' is recognized and that there is sufficient courage to set aside the original investigation and pursue this new idea. This is one of the most difficult points in the control of research. Except in the most limited applied research, you cannot lay down exactly in advance what you are going to do and what you are going to find. The budgeteers are always wrong in detail even if sometimes correct in sum. Moreover, when the unexpected does happen, when do you follow your hunch that this is something good, and when do you say that it is interesting but it will have to wait? In this connection a former member of my department once remarked that most scientific decisions are taken on aesthetic grounds. What he meant was that in many cases you chose the course of action that looked right; you had a hunch; you had a feeling for it; your decision might not be completely logical and justified on mathematical or scientific grounds—but it felt right.

It is this factor of unexpectedness that makes it so difficult for management to make the right decision as to when a piece of research should be stopped. Always there tends to be a gleam of hope, at any rate in the minds of the people immediately concerned with a project. Infanticide is a rare crime among research workers. An unsuccessful piece of research costing several thousand pounds is unfortunate but not a disaster for a big firm; but if it is allowed to run on to a hundred thousand or so and is still abortive, then it is a serious waste, not only of money but also manpower. So this is a very difficult task for management. On the whole, I would tend to err on the side of letting things run a little longer than can be justified. An interesting example of this was work we recently carried out on the modification of lead azide. We seriously considered stopping that over a year ago. The work had been going for years and continually showed promise followed by disappointment. We eventually decided on one more year, and this was one of our lucky guesses, because a very simple solution was found and the process is now being introduced into routine manufacture.

Let me come back to the second method of speculative research—to choose a target, a long-term target. This is not an easy thing to do, and it is not always within the powers of the individual researcher to do it. It is frequently a task for management who have, or should have, a wider and more mature knowledge of what is required by industry. There are a number of ways of setting about it. For example, surveys of processes in other industries—what raw materials do they need, would this or that material added to their product improve its quality? You may say that this is not research—that it is a development function. I would agree with you, but add that this is one of the very important reasons why we in Nobel Division of I.C.I. have joined together research and development, not merely in one department, but right down the line within a section where those with knowledge of the chemistry possible in a given field can rub shoulders with those who have knowledge of what are the unfulfilled demands in that field.

I may not have been able to give you a very clear picture of how to find targets but I can give you a good

example, and that is Fluothane. Here someone with the appreciation that a non-inflammable anaesthetic was desirable also had sufficient knowledge of fluorine compounds to realize the possibilities. The target was set and in not too long a time the desired result was obtained.

It is a never-ending source of wonder to me how skilfully and quickly our chemists and physicists, given a target, can reach a solution. This I think has a double message:

(1) The importance of actively searching for worthwhile targets;

(2) The woeful waste of first-class investigational ability when people are not engaged on the right task.

How much speculative work, target or otherwise, should one do? This will depend to a great extent on the nature of the company's business—if one can see a vigorous, natural expansion in existing products there is perhaps not the same urge to carry out speculative work. If, on the other hand, existing business is likely to be relatively static, there is every inducement to carry out speculative research in other fields. What one must not do is yield to the temptation to drop it when times are bad. That is the very occasion when one's effort should be redoubled, so that something may be ready for development when times improve.

Let us now edge over a little on our spectrum towards applied research and development. There are three main lines of applied research: *product improvement, process improvement, and product application.*

We are now moving into a field where much can be done in the way of critical examination of the facts before engaging in experimental work.

The first question that arises is whether the work is worth doing at all. Here I think one should always ask the question: 'Suppose this idea succeeds in accordance with my best expectations—is the result then worth while?' If the answer is doubtful then I think a great deal more thought is required before undertaking any experimental work.

Once it has been decided to carry out an investigation, thought must also be given to the best way of doing it. The great aim is to solve a given problem with the minimum of effort. This is not always remembered. One must first of all decide what questions have to be answered, and how accurately—sometimes quite rough answers are all that is required, whereas the natural tendency is to use over-elaborate and over-accurate techniques. One can then rough out the methods that seem to offer the best ways to find the answers.

There is another possible method of attack which interests me very much, although so far we are only in the early stages of it. The work-study experts have recently turned their attention to a critical approach to the problem of designing a plant. The process is broken down into a number of elements and the stock work-study questions asked about each. This is laborious but is systematic and greatly reduces the chances of something being missed. It seems to me that a similar approach could be made to research investigations—at least those of an applied and fairly definite character, and we are carrying out some trials in this direction.

However one does it, there is no doubt in my mind that one's approach to a problem can be greatly improved by good hard thinking about it. If I may quote: 'First doubt, then enquire, then discover.'

Another important thing to do at this stage is to consult the literature, and in particular the large and well-documented collection of private literature in the form of reports that are available in most industrial laboratories. You may think this is a very trite recommendation. I make it because I have had personal experience of quite elaborate investigations being carried out, and very successful ones, too—the only thing that was wrong with them was that the results were already available in the library.

Product improvement is of two types—defensive and offensive. Defensive, in the sense that to meet competition one has constantly to improve quality and if possible cheapen one's product; offensive, in the sense that one deliberately sets out to improve a product in order to attack a new market. It is difficult to assess the efficacy of defensive research, because one is not quite sure what the position would have been if one had not done it. The results of attack are usually more obvious.

Cheapening a product is another aspect of product improvement, but it is usually bound up with our next topic—process improvement. Here again it is surprising what can be done with even an old and well-established process by sitting down and asking questions about it. In most cases the answers are obvious, and one may think one is wasting one's time—but sometimes an unexpected answer comes out and one realizes that the established practice of years contains elements that are not necessarily the best. This is work that should be done in close collaboration with the plant people. After all, if the research and development department makes any changes it is the plant people who are going to be affected, and who will have to use the modified process. So I would recommend those of you in industrial research to take a critical look at your processes. Many people have queried the need for the work on so-called minor improvements to processes and suggested that research and development personnel would be better engaged on work involving newer things. I would agree with this only in so far as the process improvement work is of a plodding routine nature. If one adopts the critical approach I have suggested it can be a very worthwhile and rewarding task. A recent interesting example we have had of this

type of work has been a modification to the de-nitration system to produce clean sulphuric acid. Now that this work has been done it looks very simple—involves little in the way of plant changes and yet saves considerable sums of money. Why did we not think of it before? One reason, I think—perhaps not the only reason—was that until recently the target was not clearly presented. Once that was done progress was rapid.

Another aspect of process improvement is the need to keep in close touch with engineering and technical design personnel because very often not merely changes in process are involved, but changes in plant and chemical-engineering practice. One should not be too proud to go to other people outside one's own department. I can assure you I have seen this problem from both sides, and progress becomes a lot faster if you take other people along with you. Most people will give you a lot of help if you give them some of the credit.

Let us now turn to product applications. Here we are getting into development. You may at this stage be wondering what are my definitions of research and development. I am not going to give you any, but rather put forward the idea that both research and development involve newness, but that development is a much more orderly building up of new things on a known foundation. One should be able to plan it more completely. The element of unexpectedness, which I referred to as an essential part of research, may not be entirely absent, but it should be much less pronounced.

So perhaps we should talk about product application and product development together. Much of product application is really technical service work, and in my opinion technical service people should carry out or control their own laboratory work. I am sure that when the man who has to deal with a customer can control his own experimental work rather than have to write letters about it, greater efficiency is obtained.

And so we come to two purely development functions. The first is long-term product development and the second is project assessment and survey.

Long-term product development is essentially the search for a new product which has either been made available on the laboratory scale within one's own organization, or is available (possibly at some later stage of development) elsewhere. It is vitally important in the chemical industry, one of whose principal characteristics at the present time is that many companies engaged in it are making a major share of their profits from materials not known 15 or 20 years ago. We have tried various methods of approach. One, commonly practised in America, is to issue samples fairly widely and to hope that someone finds a use for the product. If some possible use arises, then of course help is given to the firm concerned to tailor the product to their uses or modify their process to fit. On the whole, we have found this a singularly unrewarding method, and I think this is the American experience also. The percentage of successes is so small that a wide range of products is necessary for one to have a reasonable assurance of picking a winner, and the method tends to be wasteful in materials and manpower.

Another method is to survey the American market for a product under development there. We still tend to be some years behind the Americans in markets for new products, and it is a reasonable bet that a product developing rapidly in the U.S.A. will in due course come along to the U.K. For this reason we make a continued search of the American chemical scene with a view to discovering processes that may be of interest to us and on which we could acquire patent rights or know-how. There is sometimes, I think, a certain resistance to thus acquiring processes. I think it is regarded on the research side as a little insulting and a slight on the results coming out of the research work. This is quite wrong. The field of chemistry is so wide, and one's possible interests so diversified, that it would be wrong to expect all developments to arise from one's own efforts. Cultivation of the U.S. manufacturers in the way I have described also has the advantage that it is sometimes possible to import the product for resale and thereby carry out market assessment without the expense of running a semi-technical or pilot plant. This, however, is not always possible; and one is often left in an impossible position, thinking a market might be developed for a product but unable to justify the expense of putting up a plant for it. To meet this difficulty it is desirable to put up a general-purpose pilot plant. This should be capable of making tonnage quantities of various chemicals with which one can test the market and determine whether a larger plant is justified. Here again the complete integration of the research and development functions leads to greater efficiency, since the people who have to develop uses for the products and carry out the technical service on them while they remain development products will be alongside those operating the plant.

Another aspect of development is project assessment and survey work. It is an activity for which people have to be trained. I feel that it is very useful for them to be in close contact with the research workers so that the latter may learn something of the commercial aspects of their investigations, and may indeed acquire something of the same commercial outlook. At the same time the development people learn something of the difficulties of the experimental work relating to their projects.

This type of project assessment work is an interesting but discouraging activity. It is interesting because it covers a wide field of business activity, but discouraging because out of the many things considered so many have to be turned down for one reason or another.

I would now like to pass on to what seems to me to be one of the most vital questions in a research and

development department. What is it that makes people work? I wish I knew all the answers—I think I know some of them. These are, briefly, professional interest, the carrot and the stick.

First of all there is the interest of the work. A young man coming in from the university or technical college is, or should be if he is to be any use, very interested in scientific investigation. If he has the good fortune to settle in a job where this interest can be satisfied then there is every chance that he will work away happily, at least for some years. I know that there is tremendous satisfaction in a successful investigation, whether it be the working out and confirmation of some particular theory, or of the development of a new process or process modification which one can eventually see working on the plant scale. Some of us are indeed fortunate to work in a field where this satisfaction can be obtained. I know this work has its disadvantages—one has to contend with the professional pall-bearers who have a whole host of reasons why the work should be buried in favour of some other activity, not usually specified. One has also to contend, when successful, with the band-wagon jumpers. I often wonder there are not more casualties. But, broadly speaking, it is a satisfying job. The chief pitfall to be avoided here is becoming so interested in the technical beauty of a process or investigation that one forgets to cast a critical eye from time to time at its monetary value. Let me just repeat my plea for an occasional look at problems and an answer to the question—if it succeeds, what is the profit?

Let me now turn to the carrot. People work for money. For some time it was fashionable to ignore this elementary fact, but in my opinion it is a very vital consideration. They work for money and for the prospect of making more. Some are more ambitious than others; some reckon that it doesn't make much odds, within quite wide limits, how well or how hard they work. This feeling is of course an indictment of the system of rewards used in a big company. I can only say that a great deal of thought is given to this problem and in particular to the question of whether a direct bonus scheme would be desirable. One of the difficulties is to decide who started what. A successful idea does not usually lack parents. This was one of the difficulties encountered by one or two large American firms who at one time ran a direct bonus scheme. It was found necessary to institute quite an elaborate notebook procedure with witnessing of statements and so on. This was not as bad as it sounds, because in any event it had to be done to a certain extent for the purpose of filing U.S. patents. But it tends to stifle the free interchange of ideas, which, rightly or wrongly, many British companies tend to consider an important factor in successful investigation. A further difficulty is that some people, by reason of the job in which they find themselves, have a better opportunity than others to make a contribution that has a large financial effect. They thus tend to show up more spectacularly than those less fortunately situated.

Partly for these reasons many companies rely on an assessment system—assessment of the kind of job a man has to do and how well he does it. It is, if I may mix metaphors, not a very highly-geared carrot, but the incentive is there.

Then there is the stick—regrettable, but nevertheless true. Sometimes one is forced to say to people that their performance is not adequate and that they must either improve themselves or leave. I am always very sorry for those whose performance is inadequate, but who are doing their best—I have less sympathy for the others. This leads me to the question of assessments and of telling people about them. I think myself that people should be told where they stand. If they are not doing well it gives them the chance to better themselves. If they *are* doing well they deserve to be told and the tonic effect is often considerable. So my vote is for assessment forms and disclosure of assessments. Some people of course have suggested that the research and development director should be assessed by his juniors and the result disclosed—with emphasis.

Let me now pass on to another difficult question—how much money do you spend on research and development? This can be considered both in the overall sense and in the context of how much on particular subjects.

As regards overall figures, the amount varies greatly in different industries; it is as high as 35 per cent of net output in the aircraft industry and is often around 4½ per cent of sales for big chemical companies. Within a company there is a wide range—pharmaceuticals by the nature of their business spend a high proportion of their turnover, old-established bulk products comparatively little.

This, however, is an overall picture, but each of these figures is made up of the amount which it is thought wise to spend on each project or product. This is always a very difficult thing to decide. In the case of short-term work, it is sometimes possible to estimate the likely savings or increased profits and decide how much it is worth spending to achieve one's aim. The relation between this sum and the savings will be affected by the likelihood of success—in so far as one can guess it. In defensive work on product quality, it is again difficult to estimate the worthwhile effort but this can be related to probable loss of profits if a proportion of the business is lost on account of poor quality. For longer-term and more speculative projects it is still more difficult. In all these considerations due weight should be given to the voice of other departments, such as sales, production, technical service and technical. I say due weight, but in the end, having taken their advice, one must make up one's own mind and put forward a firm recommendation. It will nearly always be accepted.

You will have gathered from the above that one of the difficulties associated with research is assessing the results in detail and in the short term. There have been many attempts at this—someone will ask 'Does research pay?' and attempts are made to assess the value of the work done. Part of the difficulty is that in the later stages of a development, other departments inevitably begin to play their part, and it is usually extremely difficult to assess the cost and value of their contributions.

In the period 1946-50 at least four separate attempts were made in a section of my firm to answer the question 'Does Research pay?' None of them, if I may say with due respect to their authors, was very convincing. The main conclusion over the period 1936–49 was that direct savings during that period more than covered the total cost of research. This left as a bonus all the intangibles such as profits retained due to improvement of products, profits from new products and so on. The fact that such an unsatisfactory measurement situation exists is, I think, one of the chief problems facing research management. Until it is solved, research and development management will remain very much an art.

This is indeed a curious commentary on an activity that should surely be the very embodiment of the scientific method.

GROUP SCHEMES FOR R.I.C. MEMBERS

Royal Automobile Club Group Scheme.—Corporate and Graduate Members of the Institute are reminded that a group scheme exists for associate membership of the Royal Automobile Club. Members of the group receive all the benefits available to individual members of the Club, including road services, legal aid, assistance with tours and technical advice.

The standard annual subscription rate of £2 2*s*. is reduced to £1 11*s*. 6*d*. for group members; in order to reduce administrative costs for the scheme it is a condition of group membership that subscriptions are paid annually, in advance, by bankers order.

Corporate and Graduate members of the Institute may join the group at any time. Further details of the services may be obtained from the group secretary, Mr J. F. Harding, at 30 Russell Square.

Why not join BUPA?—In March, 1958, the Institute arranged a group with the British United Provident Association in order to give members the opportunity of providing against the heavy costs of the private treatment of illness and accident. The group has grown steadily and there are now over 400 members. By joining the group Members become entitled to (*a*) immediate benefit on acceptance, the usual three months' waiting period being waived; (*b*) a subscription rebate of 20 per cent.

In addition, an optional extension is available by which members of the group may cover themselves against the cost of private treatment by a general practitioner.

Applications and inquiries should be addressed to the Group Secretary, 30 Russell Square, London, W.C.1.

Angewandte Chemie.—An international edition of *Angewandte Chemie*, the journal published by the Gesellschaft Deutscher Chemiker, is to be published in English jointly by Verlag Chemie (Weinheim, Germany) and Academic Press (New York and London). Each monthly number will contain review articles, selected papers, communications, conference reports, selected abstracts and book reviews. The subscription price is 107*s*. 6*d*. (plus postage), and Volume I, Number 1 will be released in January, 1962. Further details may be obtained from Academic Press, 17 Old Queen Street, London, S.W.1.

NLL News.—The first issue of *NLL News* (dated August) gives details of books and periodicals now available at the National Lending Library, Boston Spa, Yorkshire. At present a national loan service is being provided jointly by the Science Museum Library at South Kensington and the National Lending Library. For the time being the Science Museum is the major partner in this joint service and the loan and photocopy form issued by that library will be used by both libraries. The following types of literature which were previously available from the D.S.I.R. Lending Library Unit at Chester Terrace, London, or at Stanmore, are now available from Boston Spa: translations of Russian literature, including 'cover-to-cover' literature; Russian books; the 'PB' reports issued by the Office of Technical Service of the U.S. Department of Commerce; the published reports on German industry produced by the BIOS, CIOS and FIAT agencies; and certain English language, frequently-used periodicals which were on a list issued from Stanmore. Loan requests for other material, *i.e.* English language serials (excluding those referred to above) and books in languages other than Russian, should be sent to the Science Library.

BOOK REVIEWS

CHEMISTRY OF THE AMINO ACIDS. J. P. Greenstein and M. Winitz. Volume I. Pp. xxi + 760. Volume II. Pp. xi + 761–1816. Volume III. Pp. xiii + 1817–2872. *New York: John Wiley & Sons Inc.; London: John Wiley & Sons Ltd*, 1961. 800*s*.

Few groups of natural products offer the diversity of interest of the amino acids; to the organic chemist, physical chemist and biochemist they present absorbing problems, rendered urgent and compelling by the fundamental importance not only of the amino acids themselves but more especially of the peptides and proteins which they build. Antibiotics, hormones, enzymes—these provide incentive enough for the intensive studies now proceeding.

The volumes under review constitute in many ways a most fitting memorial to their senior author, Dr Jesse P. Greenstein, who died when they were very near to completion. No one could write with more authority, and few could equal his experience, in each of the different aspects of the subject. It is impossible to read these pages without being impressed by the scholarly approach and—above all—the enthusiasm which guided the task.

The three volumes are divided into seven parts: Part I, Introduction; Part II, Physicochemical Aspects; Part III, Organic Chemical Aspects; Part IV, General Analytical Procedures; Part V, Enzymes in Amino Acid Technology; Part VI, The Preparation of Protein-bound Amino Acids; Part VII, The Preparation of Amino Acids not Known to be Bound in the Proteins of Mammalian Tissues. Volume I contains Parts I, II, and a portion of III; Volume II contains the remainder of Part III, Parts IV and V, and Volume III contains Parts VI and VII. It is clear that the arrangement does not allow the separate usefulness of any one volume, and indeed they are not to be sold separately. The index is in Volume III.

The Introduction in Part I indicates the scale of the conception. A detailed account of the stereochemistry of the α-amino acids, including a particularly useful section on the configuration of diasymmetric amino acids, covers very nearly 200 pages, and this is followed by a chapter of similar size on Amino Acids in Nutrition; this, with its historical approach, makes a most readable story, enlivened by quotation and comment. Part II recounts the evidence for the dipolar structure of amino acids, and then discusses their dissociation constants and their solubilities. There is a useful chapter on Metal and Salt Combinations with Amino Acids, and a brief account of the Effect of Radiation.

Part III begins with the general methods of synthesis of α-amino acids and their resolution. Outstanding among the latter is the use of acylases with acetyl- or chloracetyl-amino acids. This general procedure, developed in Dr Greenstein's laboratory, can be applied to nearly all known α-amino acids on a large or small scale, and yields *both* optical isomers; an excellent example to give the lie to the impression given by some of the older textbooks, that biological methods of resolution necessarily destroy one of the isomers.

Part III continues in Volume II with an account of the chemical procedures for the synthesis of peptides, occupying some 500 pages. Here again, the treatment is exhaustive and historical. It is right that in a reference book such as this the early development of the subject should be recorded, but the 'classical methods of peptide synthesis' described in 100 pages are now of limited interest, and one wonders whether, for example, the preparation of acetyldehydrophenylalanylglycine is of sufficient importance to merit description with full experimental directions. This is of course an extreme case; I sympathize with the desire of the authors to provide as much information as possible, but I feel myself that greater selectivity could have been shown in choosing the 'illustrative procedures,' which must number well over 400. Most chemists would wish, in any case, to consult the original paper before repeating an experiment. It should be added that, in a number of cases, the authors' own experience has suggested modifications of published procedures, and such descriptions are of course invaluable. The discussion of more modern methods of peptide synthesis is well-balanced and critical, and every effort has been made to be scrupulously fair in assigning credit. Particularly useful are the extensive tables of important derivatives of amino acids and peptides. The development of methods for making peptides is an astonishing story; of the coupling procedures now in use, only one was known before 1950 and that one (the azide route) dates from 1902. Since 1950 a remarkable diversity of reactions has been brought into play, to cause amide formation; the use of mixed acid anhydrides with organic and inorganic acids, and of esters of weakly acidic hydroxy compounds; addition to carbodi-imides, addition to alkoxyacetylenes—and still the search for the ideal method continues, in academic and industrial laboratories. Several promising routes have appeared since the literature search for these volumes had to be closed at the end of 1958. The impetus behind this great effort lies of course primarily in the synthesis of biologically important peptides such as the hormones oxytocin and the vasopressins, hypertensin and their analogues; the achievements already include a peptide with the first 24 amino-acid residues of β-corticotropin (adrenocorticotropic hormone). It cannot be doubted

that the synthesis of insulin, even of enzymes, is an objective seriously being envisaged.

Part IV discusses colorimetric, manometric and titrimetric procedures for the analysis of amino acids and peptides; the isotope-dilution method and microbiological assay follow. The chapter on Chromatography gives a clear summary of the principles of partition, adsorption and ion-exchange chromatography, and includes interesting descriptions of the way in which paper chromatography revealed some of the rarer natural amino acids. An account of the determination of the sequence of the amino acids in peptides and proteins is followed by a summary of the evidence for the structure of natural peptides, including insulin. Chapters on Spectrophotometry, Optical Rotation, and the Determination of Optical and Steric Purity conclude Part IV.

Part V begins with a useful survey of the enzymes which are becoming increasingly important to chemical investigation in this field, for resolution of synthetic amino acids, for determining their chemical and stereochemical purity, and for sequential analysis. Experience has shown that the early suspicion that enzymes would cause serious difficulty by effecting the rearrangement of peptide chains, is largely unjustified, and enzymes are now being used increasingly as subtle and powerful tools of the chemist.

Part VI, in Volume III, discusses in turn each of the 'protein-bound' amino acids, and gives an historical account of their isolation, analysis and synthesis. It would be especially useful here, in future editions, to collect together the data on the chromatographic and electrophoretic behaviour of each amino acid (and it would be a convenience to give the specific rather than molecular rotation). Part VII describes amino acids 'not known to be bound in the proteins of mammalian tissues.' To many, the latter will be the more interesting half of this volume, for most chemists now buy the common amino acids, and their methods of synthesis are part of general organic chemistry.

The outline of these volumes makes clear the comprehensive nature of the work. The metabolism of individual amino acids is not discussed, because it has been the subject of a separate book published recently by a former colleague of the authors, and ω-amino acids are excluded. The viewpoint is that of a biochemist, and chemists might have asked for more extensive consideration of the reactions of the amino acids, and of the derivatives which have no biochemical interest. But perhaps the most outstanding impression is of the complete mastery of the subjects covered, and the style, at times a little ponderous, is continually enlivened by humour and human interest. Both young and old will delight to read Ladenburg's comment, made in 1891, that 'the younger chemists' in his laboratory had failed to hydrogenate picolinic acid, but that he had done so 'without particular difficulties . . . if one works in the proper manner.' Eyebrows may be raised when taste is included as a method for assigning optical configuration; whereas nearly all L-amino acids are 'bland or bitter,' nearly all D-isomers are sweet. There is quiet humour in the comment that 'observations of this type are of a highly subjective nature and should not, in the absence of more objective data, be employed for the assignment of stereochemical designations with any great degree of confidence.' There is an interesting evaluation of the cost of a diet based on synthetic L-amino acids; at 1956 catalogue prices, 500 g of such a diet, containing about 100 g of amino acids and about 2,000 calories, cost $71. The authors consider that improvements in resolution procedures should reduce this to some $25, and they conclude that 'some diet with all chemicals defined will become a practical reality well before the end of the earth's biological resources demand it.'

It is most unfortunate that so useful a treatise should be priced above the reach of many individuals who need it, sad to think that, in this country at least, it is likely to remain chiefly a reference book in the libraries. Perhaps this was inevitable, but one must regret that price should restrict the distribution of important publications in this way. Some sacrifice of content might have been worth while in order to make the work more generally available. The omission of some or all of the experimental descriptions, and of the extensive quotations from the original literature, would have kept the core intact, and the price more reasonable. If this sacrifice could not be accepted, then it might well have been possible so to divide the work that the volumes became separately useful. But chemists and biochemists alike will be grateful that such distinguished workers in the field should have found the time and energy to perform this service in so commendable a way.

G. T. Young

THE ORGANIC CHEMISTRY OF BORON. W. Gerrard. Pp. x + 308. *London: Academic Press*, 1961. 55*s*.

Let us hope that the obsolete and inconvenient distinction between 'organic' and 'inorganic' chemistry will soon cease to receive even lip service. Dr Gerrard's book, in spite of its title, deals with the 'inorganic' boranes and borohydrides along with the 'organic' compounds proper of boron, in fact, with most aspects of boron chemistry except that of the element itself, the borides and inorganic borates. It gives an adequate survey of these areas in surprisingly few pages, accompanied by a long and useful list of references up to 1960.

The arrangement of the material is dominated by the author's interest in reaction mechanisms. The introductory chapter, Reactivity of Alkyl and Aryl Groups, expounds some general principles of reaction mechanisms and scarcely mentions boron. In subsequent chapters, much emphasis is laid upon the ways in which a few common inorganic compounds of boron can be worked

up into organoboron derivatives, and upon the detailed machinery of the reactions involved. This novel approach is interwoven with a more traditional subdivision of material by classes of compounds. The result is good except in one respect. There is only brief and uncritical discussion of the factor which gives boron its unique interest, namely its peculiar bonding properties.

The book includes valuable short reviews of a number of topics of strong current interest to research workers. These include the hydroboration of olefins, reduction of organic substances by borohydrides, the chemistry of the tetraphenylborates, reactions of diboron tetrachloride, cyclic compounds of boron with carbon, nitrogen, phosphorus, oxygen and sulphur, and the infra-red spectra of boron compounds.

Anyone interested in boron chemistry or organometallic chemistry will find this book useful as a source of information, ideas and references. It cannot, however, be described as entertaining reading. The complicated and obscure style in which many passages are written often confuses instead of enlightening, and the reviewer found that real determination was needed to get through more than a few paragraphs at once.

H. G. HEAL

AZO AND DIAZO CHEMISTRY: ALIPHATIC AND AROMATIC COMPOUNDS. H. Zollinger. Translated by H. E. Nursten. Pp. 444. *New York: Interscience Publishers Inc.; London: Interscience Publishers Ltd*, 1961. 124*s*.

Chemie der Azofarbstoffe, a survey of the chemistry and technology of azo dyestuffs by Professor Zollinger, was published, in German, in 1958 and was very well received (*cf.* review in *J. Soc. Dyers and Col.*, 1959, **75**, 156). Nevertheless it caused a nagging frustration amongst diazo-chemists, since inevitably it included much material of interest to them but whose usage was limited by the German text. In the previous decade there had been what almost amounted to a revolution in diazo-chemistry, brought about by the systematic investigation of the fundamentals of the subject by modern physical techniques (especially reaction kinetics). Diazo-chemists were painfully aware that the only way to get at most of this new information was to go to the original literature. Now this very important book has not only been translated but the opportunity has been taken to create what is largely a new work, and one conceived on the grand scale. The original chapters on diazotization, diazo-equilibria, isomerization, reactions of diazonium ions, azo coupling, properties (and metal complexes) of aromatic azo-compounds have been, the author claims, thoroughly revised, brought up to date and partly rewritten. Much of the material of concern only to the dyestuffs technologist has been omitted. The author now incorporates something completely new, namely a comprehensive review of the corresponding aliphatic compounds. The latter has never been previously attempted and every opportunity is taken to build bridges between the aliphatic and aromatic fields, using modern views of reaction mechanisms as the common basis.

Zollinger's theme is essentially a physical one but this book is not just for physical chemists. Professor Zollinger has been intimately associated with the dyestuffs industry for a very long time and it is not surprising to find that he tries to present his material in a manner that will ensure its widest reception, but without too much deliberate oversimplification or dilution. He has been very well served by his translator, so much so that 'translation' is hardly relevant here at all. The book is extremely readable, the massive amount of material utilized for it having been well digested and attractively produced. This is 'modern organic chemistry' in every sense and will do much to overcome prejudices by those who still favour the empirical approach alone. However Zollinger is honest enough to admit the limitations of the physical method of approach. After examining, in great detail, recent work on mechanisms of diazotization, he carefully discusses the application of the results to the practical process. He implies that for all their fascination as an exercise in physical chemistry there is little to add to what the empiricists have previously discovered, apart from the possibility of designing machinery for continuous diazotization. Nevertheless in discussing catalysed diazo decompositions he fails to stress that the decisive factors here are often 'mechanical' rather than chemical in nature. These reactions usually proceed very quickly, large amounts of gas are evolved and often a solid catalyst participates. Thus the physical form of the catalyst, the need to dissipate stabilized foams and secure rapid efficient mixing are aspects that are all too easily forgotten.

In places the book reveals astonishing prejudices and ignorance of long-established techniques. There is no special reference to the universal methods of diazotization invented by the Hodgson school. These methods are not merely techniques for obtaining diazo solutions but lead on to extremely valuable methods for preparing solid diazonium compounds (including pure ones for physical chemical studies!), for deamination, for replacing the diazo group by halogen, nitro-group, etc. Similarly Zollinger's discussion of the importance of removing nitrous acid from diazo solutions fails to mention that diazo solutions containing nitrous acid and made to react in neutral or alkaline medium must inevitably produce side-products in which the diazo-group has been exchanged for the nitro-group.

The book is extremely up to date, quite recent work is written into the text and there are references to papers of both 1960 and 1961 amongst the 2,700 quoted. Having no rivals, this book is bound to be in great demand both by academics and technologists.

Fortunately this is a benevolent monopoly and there will be no regrets about the not inconsiderable sum asked for it.

E. R. WARD

BENZOLES—PRODUCTION AND USES. Edited by G. Claxton. Pp. xiii + 979. *London: The National Benzole and Allied Products Association*, 1961. 105*s*.

The appearance of this book is an important event for the carbonizing industry in general, whether emphasis be upon gas or upon coke manufacture. In all respects it is a worthy successor to *Motor Benzole, Its Production and Use*, first published in 1931 and revised in 1938. The latter, long regarded as a standard work in the field of benzole technology, has been left far behind by the developments of the last decade. The present emphasis is upon benzole as a source of pure aromatic hydrocarbons for chemical industry, rather than as a motor spirit, although a chapter is devoted to this aspect.

The scope of the book is wider than the title suggests, carbonizing plant and its operation and the purification of gas prior to benzole extraction being covered; there is also a chapter upon the instrumentation of benzole recovery and refining plant, and a most useful section summarizing available information on the physical properties of the individual components of benzole.

The whole work is well documented and contains over 1,300 references, the lists of these being placed conveniently at the ends of chapters. The name index with this scheme enables any of the references to be found very quickly; only once did this fail, owing to a spelling error, Schuftan having been consistently represented without the 'c.' However, it is fair to add that the text is reasonably free from such errors; less than half a dozen were noticed and only the above is of any significance. The type-face is clear and easily read and the illustrations are of excellent quality, although in studying the latter carefully the slight transparence of the rather thin paper was a nuisance.

J. H. TOWLER

TOXIC PHOSPHORUS ESTERS. CHEMISTRY, METABOLISM AND BIOLOGICAL EFFECTS. R. D. O'Brien. Pp. xii + 434. *New York: Academic Press Inc.; London: Academic Books Ltd*, 1960. 103*s*. 6*d*.

The fact that certain phosphorus esters now widely employed as insecticides have been investigated extensively with a view to their possible use in another and somewhat different type of chemical warfare gives these compounds a rather unusual significance. Add to this the fact that with these compounds, unlike most toxic agents, considerable progress has been made towards an understanding of the precise way in which they exert their effects on living organisms, and it becomes apparent that much interest can be expected to attach to an account of their chemistry, metabolism and biological effects. The readers of Professor O'Brien's monograph will not be disappointed. The author has set out to interpret the biological effects produced by the toxic phosphorus esters in terms of events at the molecular level. To use his own words, he has attempted to show '. . . how to a great extent our knowledge of the chemical properties leads us to understand the biochemical properties, how these in turn enable us to interpret events at the physiological level, on isolated or partially isolated tissues, and then how this grand complex of understanding enables us to comprehend what happens when organophosphates are applied to the whole animal.'

As is to be expected, the book is dominated by the fact that the toxic organophosphates are esterase inhibitors, and that the acute toxic effects which they produce in higher animals appear to be related almost entirely to their inhibition of the cholinesterase of the nervous system. After an introduction in which he deals with questions of nomenclature and with the structure and biological significance of cholinesterase, the author considers the non-enzymic reactions of the toxic phosphorus esters. He goes on to describe their reactions with cholinesterase *in vitro* and then reviews the enzymic processes which change their anticholinesterase activity, in some cases intensifying it and in others reducing it. He next describes the effects of the toxic organophosphates on isolated tissues, principally nerve and muscle, and proceeds to an examination of the action of these compounds in mammals, insects and plants. He then deals with selectivity of action and takes up the question of the application of our present knowledge to the development of compounds with toxic effects which are predictable.

This is an excellent book and one which, in its approach and presentation, has much to teach those who write on toxicological subjects.

LESLIE YOUNG

THE COLLECTED PAPERS OF PAUL EHRLICH. VOLUME II. IMMUNOLOGY AND CANCER RESEARCH. Edited by F. Himmelweit. Pp. viii + 562. *Oxford: Pergamon Press Ltd*, 1960. 160*s*.

This expensive and beautifully produced volume contains the papers published during Ehrlich's second main period, when his interests were predominantly concerned with the phenomena of immunity. The volume contains 51 papers in all by Ehrlich and his collaborators. A number of these are in the form of review articles and lectures; the final nine papers deal with cancer research in the period 1905-1909. Forty-four of the contributions are in German, and of these, English translations are provided for seven, a further six appear in English for the first time and one (No. 19) in French. The papers are divided into Early Studies in Immunity and Immunotherapy (Nos 1-12) covering

the period 1891-94; Studies on the Mechanism of Immunity Reactions, Nos 13-42, 1897-1905 (14a, 17a, 18a, 21a, 22a, 23a and 24a being English translations from the German originals); and Cancer Research (Nos 43-51).

Any more than the Bible, a volume of this kind does not lend itself to review in a short space. Fortunately Sir Henry Dale, who again contributes the introduction, as he did the general introduction to these volumes, outlines the natural development of Ehrlich's ideas from his interest in synthetic dyes, which enabled him to make important contributions to haematology, bacteriology and pharmacology through an instinctive understanding that the time (1891) was not yet ripe for effective advance in chemotherapy, and thus to a realization of the important therapeutic possibilities of the antitoxins discovered that year by von Behring and Kitasato. Ehrlich's consequent researches in the field of humoral immunity gave rise to his famous 'Side-chain Theory.'

The cancer work was mainly concerned with malignant tumours which could be carried in mice and of the changes which could be produced in the virulence of these tumours by passage and selection. Despite the excellence of this research it now exists as an isolated episode in his life's work.

It is of interest to read of the trouble Arrhenius made for himself when he likened the combination of diphtheria toxin with its antitoxin to the neutralization of a weak acid by a weak base. One comes with a shock to the sentence (p. 141): 'When one cell simultaneously produces two asymmetrical components, it frequently occurs that the two components are formed in exactly the same amount, *e.g.* inactive oxalic acid.' This is from an article by Ehrlich translated into English before publication, and perhaps the translator is responsible. Again, one reads with surprise the note in the Third Herter Lecture: 'Literature of recent years almost too great to master.' What would Ehrlich think of the literature problem now, less than 60 years later?

This is a volume of great interest and will find its way to the shelves of most scientific libraries.

V. C. BARRY

SOAP FILMS. STUDIES OF THEIR THINNING. K. J. Mysels, K. Shinoda and S. Frankel. Pp. x + 116. *London: Pergamon Press Ltd*, 1959. 40*s*.

This book provides an account of some novel and interesting observations the authors have made on soap films, using mainly optical methods. They have attempted a quantitative treatment of drainage processes, which in the case of slow-draining films has met with some success. However, 'with other types of film, our understanding is incomplete and at best qualitative.' It must be emphasized that this book is concerned with individual films, and such applications as foam stability are not considered, a fact made quite clear in the preface. Irreversible films such as those of saponin are not considered because of their 'very special behaviour.'

In my opinion, it is a pity that this work has not been subjected to the discipline of preparation for publication in a scientific journal. The advantages of such a course would have been two-fold. In the first place, a more precise style would have emerged and the 'meat' would have been more easily extractable. Secondly, the results, which do contribute to our knowledge of the subject, would have received wider circulation. As it is, however, parts of the text read like laboratory or lecture notes and some sloppy, not to say inaccurate, statements have been found, such as on p. 67, where we read that 'Pure sodium lauryl sulfate was prepared . . . by *sulfonation* [reviewer's italics] of dodecyl alcohol. . . .' This substance, which is used for much of the experimental work, also appears under the aliases 'sodium dodecyl sulfate' or just 'lauryl sulfate' throughout the text.

At its price, it is doubtful whether it will appeal to any but the specialist, who will find in it much that is new. The bibliography of well over 300 references (related to films rather than foams) will also be of use to him.

K. G. A. PANKHURST

PRINCIPLES AND APPLICATIONS OF PAPER ELECTROPHORESIS. (Elsevier Monographs.) Ch. Wunderly. Pp. xii + 253. *Amsterdam: Elsevier Publishing Co.; London: D. Van Nostrand Co. Ltd*, 1961. 26*s*.

This book is one of a series of Elsevier Monographs which includes *Agar Gel Electrophoresis* and *Zone Electrophoresis in Blocks and Columns*. The book is divided into an introduction (3 pp.) and sections on theoretical foundations (17 pp.), methods (26 pp.), technique (38 pp.), results (mainly proteins, 96 pp.), and references (46 pp.), as well as subject and author indexes.

The intention of the author was to produce an up-to-date review of methods and results, and there is no doubt that he has succeeded. With careful study, it is possible to find all the necessary details to enable paper electrophoresis to be carried out successfully, together with a discussion of the various errors and interfering factors which make the technique somewhat hazardous for the beginner. It is also obvious from the work that although paper electrophoresis is practised with reasonable success by the majority of routine hospital laboratories there is still a great deal to be learned about the basic principles and practice of this technique when it is applied to other fields. This may well explain why electrophoresis has not achieved the same popularity outside the field of proteins, although the technique should prove equally valuable in the separation of many other families of chemical compounds.

Although paper electrophoresis has been invaluable in the investigation of serum proteins, in my opinion it

is now being replaced by cellulose acetate electrophoresis, and this replacement will be accelerated in the future if high-quality acetate can be manufactured. It is therefore unfortunate that acetate is not mentioned, even in passing, as an alternative which has many advantages when compared with paper.

The book is well produced and easy to read. It appears almost free of errors, although the section on low voltage is entitled high voltage at the top of the relevant pages. For those interested in the general application of paper electrophoresis or the results obtained from its application in the field of serum proteins, this book is well worth reading, although somewhat expensive.

I. Smith

GAS CHROMATOGRAPHY ABSTRACTS 1960. Edited by C. E. H. Knapman and C. G. Scott. Pp. xi + 200. *London: Butterworths*, 1961. 42*s*.

This volume, the third in a series sponsored by the Gas Chromatography Discussion Group, contains a comprehensive collection of abstracts of 1960 publications on gas chromatography. The first two volumes of the series, which together cover publications up to the end of 1959, have already been reviewed (*J.*, 1960, 245 and 359).

The volume under review contains 875 references, most of which are abstracted in 2-12 lines of type. As in earlier volumes, there is an excellent subject index, which enables the reader quickly and efficiently to trace publications and survey work already carried out in one particular aspect of the field. An alphabetical list of the authors of each paper is also included as an alternative means of tracing publications.

Adverse criticisms of the series are of a very minor nature; these have been cited in the reviews of earlier volumes, and some still hold for this 1960 volume.

The usefulness of these abstracts to workers in the field of gas chromatography cannot be over-emphasized, and this is a book which should find a place in every laboratory where this important analytical technique is employed.

A. McLean

DIE COULOMETRISCHE ANALYSE. (Monographien zu 'Angewandte Chemie' und 'Chemie-Ingenieur-Technik' Nr 71). K. Abresch and I. Claassen. Pp. xi + 228. 1961. DM 24.00.

ELEKTROMETRISCHE pH-MESSUNGEN UNTER EXTREMEN BEDINGUNGEN. (Monographien Nr 74). K. Schwabe. Pp. 95. 1960. DM 12.50.

Weinheim: Verlag Chemie GmbH.

The first of these publications is one of the larger monographs, No. 71, published by *Angewandte Chemie* and *Chemie-Ingenieur-Technik*, and offers a welcome 'first' in the field of coulometric analysis, which has hitherto been accorded only sections in larger works on electroanalytical chemistry.

Though Abresch has published no more than a couple of papers in the field, he has been interested in coulometry for many years and is counted by Professor Willy Oelsen, one of the earlier workers, as eminently competent to deal with it. In this Oelson's confidence appears to be justified, and a number of Abresch's researches are described in this work for the first time.

Classification of material is good, even meticulous, throughout, but the treatment of principles is rather brief and superficial. In fact the whole treatment, while meaty and comprehensive, tends to the brief and tantalizing. This is proper enough in a text purporting to introduce a technique to a wide circle of potential users, and which offers a key to the particular literature, though this is rather less than the declared aim.

After a somewhat brief but systematic survey of principles, current efficiency, location of end-point and interpretation of current–potential curves, there follows an again systematic treatment of electrodes, diaphragms, cells, coulometers, potentiostats, amperostats, time measurement, automation and impulse coulometry. Actual determinations are covered by giving illustrative working examples of each class of technique and reaction followed by a comprehensive tabulation including much useful detail and references to the literature.

The authors have been at considerable pains to cover as many aspects of the field as possible within a limited compass, and this has led to an economy of style which has sharpened the lucidity of their writing, to the benefit of the reader.

Anyone with a deep interest in the subject will have to pursue it beyond this book, but means to this end are provided in the extensive bibliography of over 500 references carried into 1959. Those seeking to learn something of coulometry and its possible application to their own problems will find adequate explanation and directions here, and will also find their curiosity aroused and interest titillated.

The second smaller monograph (No. 74) was engendered by the growing technical necessity and importance of pH measurements in the region below 0 and above 13 and also at elevated temperatures and in diverse media. An attempt is made to survey this field and to make a critical assessment of the accuracy of measurement and of the physical meaning and significance of the measurements.

Following some introductory matter, the text is divided into three sections, treating respectively extremes of acidity and alkalinity (15 pp.), measurements at high temperature and pressure (36 pp.), and nonaqueous media (22 pp.). A brief summary and excellent author and subject indexes round off the work. The literature is selectively surveyed up to late 1959 in about 100 citations, the majority of which are in the last decade. The author concludes that electrode systems

are available which give dependable and reproducible responses under all the extremes of condition encountered, but that it is not possible to arrive at the hydrogen ion activity directly from electrode response. Conventional pH values and empirical comparisons can, however, afford valuable information.

Of all the sections that on temperature is perhaps the best done; but they are all sound, and the coverage is well chosen to provide an understanding of each topic sufficient to work intelligently in each.

Production is excellent, and this thoughtful and stimulating monograph should be welcomed by all who have to do with the technology or physical chemistry of hydrogen ion concentration under extreme conditions.

E. BISHOP

THE COLLECTED WORKS OF IRVING LANGMUIR. Volume III. Thermionic Phenomena. Pp. xxviii + 481. Volume IV. Electrical Discharge. Pp. xxii + 409. Volume V. Plasma and Oscillations. Pp. xx + 261. Volume VI. Structure of Matter. Pp. xxxiv + 305. Edited by C. G. Suits and H. E. Way. *Oxford: Pergamon Press (with the editorial assistance of the G.E.C.)*, 1961. 100*s.* per volume.

Irving Langmuir was born in Brooklyn, New York, in 1881. In 1898 he went from high school to Columbia University, where he took a degree in metallurgical engineering in 1903. He then began his training in research at Göttingen, studying the dissociation of gases at elevated temperatures. Nernst, who directed these studies, apparently did not discern in his pupil any unusual degree of talent. After graduating Ph.D. in 1906, Langmuir returned to the United States and taught chemistry for three years at the Stevens Institute of Technology at Hoboken, New Jersey. At the age of 28, he joined the General Electric Company as a research scientist. From then until his death in 1957 he remained associated with that company, and while in its service produced a continual stream of work of originality and distinction in chemistry, physics and meteorology.

After Langmuir's death in 1957, it was decided by the Pergamon Press to produce an edition of his collected works in (according to the preface) about four volumes. But (perhaps because no one had counted the pages of Langmuir's papers) the project grew and the four volumes under review form only one-third of the whole.

The papers in Volume III were written between 1913 and 1937. Some are concerned with Langmuir's contributions to establishing Richardson's work on thermionic emission, particularly by improved experimental technique and by interpretation of space-charge effects. The subsequent developments both in theory (especially the replacement of the Maxwell distribution by the Fermi distribution) and experiment (the discovery of the dependence of work function on the crystallographic plane emitting) do not rob them of their historical interest. Others, which deal with the observation and interpretation of the influence on electron emission from tungsten of adsorbed films of caesium and thorium, remain true in essence today. Many general chemists will find two other papers of equal interest to these: one describes the invention of the mercury vapour condensation pump and another discusses the seat of electromotive force in the electrolytic cell. The volume has an introduction by Dr J. A. Becker, which attempts in brief compass to survey the contents.

Volumes IV and V present Langmuir's work on electrical discharges and intensely ionized gases—for which he introduced the word 'plasma.' They contain formidable papers and reviews, among them those with Mott-Smith (1924) and K. T. Compton (1930, 1931) which have become classics in their field. The introductions to both Volumes IV and V are written by Dr Cobine.

Volume VI on the structure of matter is perhaps the most interesting to the chemist. The papers in it are engagingly and informatively introduced by Dr D. Harker. They are rather awkwardly divided into two groups, one labelled atomic structure and the other, molecules and crystalline structure. In the first group are placed Langmuir's papers on the octet theory of valence and in the second the papers on isomorphism, isosterism and covalence. These immensely influential contributions which are close in time (1919) and topic are somewhat uneasily separated by an unfruitful, slightly later, paper on helium. The remainder of the second part of the book has some of the papers (overlapping in date and subject with Volume VIII) which Langmuir wrote on molecular aspects of the interface and which excitingly convey his quantitative feeling for all phenomena. The same aspect of his intellect is displayed in the 1938 paper which explores the influences of intermolecular forces in colloidal systems.

The whole series of 12 volumes comprise some 224 original papers, notes, letters to editors, and wartime research reports. The format of the original journals is not retained, losing the pagination but conferring the advantage of uniform appearance. Errors of transcription (such as the definition of the bar as 'a pressure of one degree per sq. cm') are very few. Not every paper Langmuir wrote is reprinted (presumably to avoid undue repetition). As the list provided is actually a set of contents of each volume, this means that one would have to search among footnotes to make a complete list. This may not be serious but neither is it scholarly, and it is curious that Langmuir's book *Phenomena, Atoms and Molecules* is referred to only in a similarly offhand way. One feature mitigates this criticism: those papers which are printed have been given a serial number in chronological order. Division of the papers among 12 volumes is reasonably successful (inevitably some items are misleadingly placed: Volume I, Low Pressure Phenomena

does not include the papers on the mercury vapour pump, which occur in Volume III). Two opportunities have been missed in the introductions to these four volumes. The developing pattern of Langmuir's interests is not adequately dissected within each topic (though the whole collection is a monument to them). And the interchange of his ideas with those of his collaborators could have been explored. While so many of Langmuir's contemporaries are alive, this omission is particularly unnecessary and unfortunate.

The questions arise: for whose benefit are these volumes produced, and will a chemist or a chemical library wish to acquire a set? Much of Langmuir's most famous work has been superseded or is today regarded from a different angle. Few individuals are likely to acquire these four volumes and fewer still the whole set, as they might some authoritative monograph; Langmuir's very width of interest itself detracts from the probablilty: their appeal may be greater to the historian of science. Nor need any but the wealthiest laboratory libraries hasten to acquire them, for few of these papers, important as they are, are not already accessible on their shelves in standard journals (though this is not true of Volumes X–XII). It is also unfortunate that the binding should look so shabby and the lettering appear of very low quality in a set of books selling at five pounds apiece: the answer to the first question is that the volumes are certainly not *obviously* produced for the benefit of the purchaser.

PETER GRAY

INFRARED ABSORPTION OF INORGANIC SUBSTANCES. K. E. Lawson. Pp. vii + 200. *New York: Reinhold Publishing Corporation; London: Chapman & Hall Ltd*, 1961. 54*s*.

This book provides for the first time a review of the applications of infra-red spectroscopy to problems in inorganic chemistry. These applications have lagged considerably behind those in the organic field, but in recent years quite an extensive literature has built up and it is appropriate at this stage of development that it should be reviewed and collected in one comprehensive bibliography. In performing this task the author deserves our thanks, but it is a pity that the opportunity was not taken to assemble a collection of inorganic group correlations as a companion volume to Bellamy's *Infrared Spectra of Complex Molecules*. On reading the title, my immediate reaction was to compare the text with Bellamy's, but a cursory glance soon revealed that, apart from its undoubted value as a bibliography, this was not the significant event for chemists interested in the infra-red spectra of inorganic compounds that I had hoped for. It is true that 26 tables of frequencies are given but these are mainly lifted from the literature rather than assembled from many sources.

Apart from a brief introduction (Part I) the book falls into two parts: Part II, 63 pages under the heading 'Spectra-Structure Correlations'; and Part III, 102 pages of bibliography. It is far more difficult to classify inorganic than organic compounds as far as their infra-red spectra are concerned, but of the several possible methods the choice taken in Part II, of elemental, binary, ternary and complex compounds, seems hardly appropriate. As a result, it is extremely difficult to use this section for looking up the frequencies of related compounds without resort to the index. Worthwhile features of this Part are the tables of frequencies of, for example, the highly symmetrical tetrahalides of Group IV elements and the hexahalides of Group VI, included as applications of spectra to problems of molecular shape.

Part III does serve as a comprehensive source of papers on infra-red topics involving inorganic substances, published in the last decade, and there appear to be no major omissions. This part is extremely valuable; it is clearly set out in years with full titles (translated where necessary) and brief summaries. These two main parts are interspersed by a glossary of terms which, including as it does definitions of words such as amorphous, deutero- and hygroscopic, is more of an insult to a practising chemist than a serious aid.

The printing and indexing are excellent, and errors are not too numerous for a bibliographic work. As a compilation of more than 1,100 original papers the book is a valuable work of reference for both the established spectroscopist and the newcomer to the field.

H. E. HALLAM

SPECTROCHEMICAL ANALYSIS. Second Edition. L. H. Ahrens and S. R. Taylor. Pp. xxiii + 454. *Reading, Mass.: Addison-Wesley Publishing Co. Inc.; London: Pergamon Press Ltd*, 1961. 105*s*.

In the 10 years since the first edition of this standard monograph, written by Professor Ahrens alone, there have been few changes in the basic techniques of analyses using direct-current arc excitation. This is the only source considered in the book, which is restricted in its subtitle to the analysis of geological and related materials but is really relevant to most non-conducting powders. The changes in the new edition, which includes some material from Ahrens's *Quantitative Spectrochemical Analysis of Silicates* (Pergamon Press, 1954), are concerned mainly with advances in our knowledge of the principles governing the processes involved, and with improvements in such factors as choice of internal standard. The application of direct-reading techniques to d.c. arc work has certainly been slow, but it is unfortunate that no reference has been made to Ward's work on glass sands and other materials, published in 1959, in which remarkable precision has been attained.

An important development in the past few years has been the more general realization that, properly used, the d.c. arc source can equal other sources in accuracy. More emphasis is placed on anode excitation, as this is the source with which both authors have had most

experience, but cathode-layer excitation is not entirely ignored. No one has yet made a thorough comparison of their respective merits, as both require considerable experience before the best possible results are obtained.

In 1950-1960 there have been many publications describing applications of arc techniques, and this new edition serves a very useful purpose in bringing them together in a 46-page bibliography, in which more than half the papers cited appeared during this period. The text is not without minor slips, for instance 20 gm on the last but one line of p. 259 should read 20 mg.

The improved and expanded second edition must inevitably replace the first on every spectrographer's bookshelf, as it is the most comprehensive treatise on arc excitation available. One wonders, however, if the high price could not have been reduced by omitting the 70 pages of wavelength tables, particularly as they have been published separately.

R. L. MITCHELL

THE ABUNDANCE OF THE ELEMENTS. INTERSCIENCE MONOGRAPHS AND TEXTS IN PHYSICS AND ASTRONOMY, VOLUME VII. L. H. Aller. Pp. xi + 283. *New York: Interscience Publishers Inc.; London: Interscience Publishers Ltd*, 1961. 75*s*.

This book, which forms part of a series devoted to physics and astronomy, is evidently intended primarily for astrophysicists, but it contains much of interest to chemists.

The study of elemental abundances is of great significance in connection with the problem of the synthesis of the elements, or more precisely that of nucleogenesis, and it is mainly in this sense that the matter is discussed in the present work. There is a fairly brief consideration of purely chemical analytical data that are of course only of interest in connection with the earth and meteorites. A large part of the book is devoted to investigating the problem of interpreting quantitatively the spectra of the various types of heavenly bodies, and it emphasizes the great difficulties attending the use of spectra from sources, the physical conditions and mode of excitation of which can only be known by inference.

It now appears that the most reliable values for elemental abundances are derived from a variety of sources—in some cases from the earth's crust and from meteorites and in other cases from solar, stellar or nebular spectra. The older view of an approximately uniform composition of the universe has been dropped, and individual stars are recognized as the locations in which element building takes place.

The author presents a carefully considered compilation of abundances based partly on the tables of Suess and Urey (1956), Cameron (1959) and Schmitt (1960), as well as some of his own values.

To the chemist the greatest interest of the book will be in the last chapter, where modern theories of the origin of the elements are discussed with emphasis on the 'B_2FH' paper (Burbidge, Burbidge, Fowler and Hoyle, *Rev. mod. Phys.*, 1959, **29**) and developments from it. It is shown that a consistent theory of nucleogenesis from hydrogen that can explain almost all the known facts about elemental abundance and distribution is now possible. In addition, considered reasons for rejecting the older 'frozen equilibrium' hypothesis are given.

The production of this work is of the expected high standard, and very few errors were detected. In a casual reading some slight misunderstanding of some of the tables could be caused by use of the symbol *A* for mass number and then *log A* for the logarithm of the abundance, and again when the abundance is in terms of number of atoms and *log N* appears in the table.

The book can be commended to all chemists interested in nuclear problems and should certainly find a place in chemical libraries. It is unfortunate that the price places it rather beyond the range of many students.

F. H. DAY

ADVANCES IN FLUORINE CHEMISTRY. VOLUME II. Edited by M. Stacey, J. C. Tatlow and A. G. Sharpe. Pp. 220. *London: Butterworths*, 1961. 45*s*.

It was clear from the first volume in this series that the editors had devised the right medium through which to present the wide front of the advance in fluorine chemistry. In it, they catered for the specialist in a way that encouraged rather than repelled the general reader, and at the same time gave a good choice of subject matter. This plan has not been departed from in the second volume. In it, Dr C. R. Patrick (Birmingham) deals with the thermochemistry of organic fluorine compounds; Dr G. C. Finger (Illinois Geological Survey) with fluorine resources and fluorine utilization; Dr J. R. Majer (Birmingham) with mass spectrometry of fluorine compounds; Dr J. M. Tedder (Sheffield) with the fluorination of organic compounds with elementary fluorine; Dr N. Hodge (A.E.R.E. Harwell) with the fluorides of the actinide elements; and Dr B. C. Saunders with the physiological action of organic compounds containing fluorine. As before, every article is preceded by a summary of contents and provided with an up-to-date bibliography; there is also an adequate index. The coverage of the topics shows discrimination, the theoretical background is sufficient and many useful numerical data are provided. There are appraisals of the present state of knowledge and clear indications where information is lacking or uncertain.

Dr Patrick's chapter, with its sections on bond-energy terms and bond-dissociation energies, and Dr Majer's account of the mass spectrometry of aliphatic and aromatic fluorine compounds provide fundamental information for those engaged in synthetic and degradative experiments in this field. One aspect of such work is handled by Dr Tedder, who considers the methods used in the fluorination of organic compounds

with fluorine itself. When plants are designed to produce six tons of liquid fluorine a day and the fluorine recovered from waste gases has become an industrial source of the element, the need for Dr Finger's contribution is obvious. Dr Hodge gives a very clear picture of the fluorine compounds of the actinides from actinium to curium. He displays the relationships between them and gives the physico-chemical information upon which their present technology is based. It is timely that a brief authoritative statement on the physiological action of fluorine compounds should be made conveniently available when so many of them are now investigated in laboratories and employed in industry. Few who dip into Dr Saunders's most readable chapter are likely to leave it unfinished or fail to recognize the seriousness of its message.

Having seen this second volume in the series, I look forward with sustained confidence to the third. But why are the contents of the first volume given only on the dust cover of the second? It would surely be convenient to have such information on the end-paper of this and subsequent volumes.

P. L. ROBINSON

INORGANIC CHEMISTRY. A GUIDE TO ADVANCED STUDY. R. B. Heslop and P. L. Robinson. Pp. viii + 555. *Amsterdam: Elsevier Publishing Co.; London: D. Van Nostrand Co. Ltd*, 1960. 45*s*.

The awakened interest in inorganic chemistry has resulted in, and has in turn been helped by, the appearance of a few textbooks which have attempted to do more than catalogue the properties of the substances they deal with. It is a pleasure to welcome another to this small fold. The book is addressed to students and teachers up to honours degree level, and it will be appreciated principally by them. It will also be of value to many who have left their academic studies behind, but whose work or interest continues to be in the inorganic field and requires a synopsis of modern principles and developments.

The first 10 chapters, almost half the book, summarize the theoretical, and to a small extent the experimental, background of inorganic chemistry. They deal with the nucleus, electronic configuration and valency, structural chemistry, chemical thermodynamics and kinetics, and acids and bases. The deliberate omission of much material of only historical interest and the conciseness of the treatment have produced a synopsis which is very valuable to the student who uses it for reference. The degree of compression might at some points confuse the reader who relies on it to the exclusion of other instruction in physical and theoretical chemistry, which it is not intended to supplant. Somewhat fuller descriptions of the applications and limitations of experimental techniques would be welcome.

It is in these chapters in particular that the authors' policy of omitting literature references is felt to be wrong. It would indeed be out of place to give references to original work, but critical references to review articles and to fuller treatments of some topics would help to compensate for the brevity necessary in such a comprehensive textbook.

The second part of the book deals with the elements in turn, covering their properties and those of their main compounds, with emphasis on structural information. Useful comparative treatment is given where appropriate, and there are liberal cross-references to the earlier chapters. There are separate chapters on hydrides, oxides, halides, complexes and peroxides, and a brief outline of separation methods. Strict attention to compression has again produced a valuable synopsis of a large amount of material.

In such a work it is inevitable that every critical reader will find a satisfying number of minor things to deplore. It is, perhaps, a matter of definition whether lanthanum should be termed a lanthanide, and actinium an actinide, but if they are, the definition is difficult to extend to transition elements. Chemically it can be justified, but then thorium on the same grounds should be compared with Group IV and uranium with Group VI, and not with the actinides. A chapter on inorganic polymers will undoubtedly appear in future editions.

I must resist the temptation to mention other topics and treatments which might have been expanded. One of the most considerable of the tasks which faced the authors must have been to choose the material to be excluded. They have done admirably and have conveyed clearly to the reader their enthusiasm for and their mastery of their subject. In the hands of students, the book cannot fail to further the resurgence of inorganic chemistry that it reflects. DAVID W. WILSON

TITRIMETRIC ANALYSIS: AN INTRODUCTORY COURSE. N. B. B. Johnstone and T. C. Downie. Pp. 186. *London: University of London Press Ltd*, 1961. 13*s*. 6*d*.

Undoubtedly there is a need for an elementary book on titrimetric analysis based on modern concepts and this book attempts to meet that need. However, the arrangement of the material is somewhat unconventional. For example, techniques are not described until the last section of the book (Part IV) along with miscellaneous information. The logical order is to describe techniques immediately after titrimetric analysis and its objectives have been defined. Moreover, the list of abbreviations and symbols should have been given either at the beginning or at the very end of the book.

The various sections of the book are not well co-ordinated and there are several inconsistencies. For example, although students are shown how to calculate equivalents by the method involving the use of electron-transfer reactions and by that using 'available' oxygen, the latter method is almost always used in the practical exercises. This is surprising in this day and age.

Examples of the methods for calculating results are given but these are set out in a general way and usually end with an equation to be solved such as :

$$\text{Equivalent of magnesium} = \frac{W \times 1000}{(25{\cdot}0 \times F_2 - y \times F_1).}$$

This offers a sore temptation to students merely to substitute values in the equation, so obtaining a result without an understanding of the principles involved.

The authors claim that their book has sufficient subject matter in it for second-year university courses. This is doubtful. While the authors do define a molar solution and point out that 'for a particular substance the G.M.W. has a constant value unlike the G.E.W. which may vary according to the reaction in which it is involved,' seldom is the molar system used in the book. Second-year university students should have been weaned from the normality system and be familiar with the molar system and the relationship between the two.

Part I lists some definitions and explanations, but, possibly through the authors' laudable attempt to condense their material, a number of these are unsound. For example, complex salt is said to have one or more complex ions and to give one kind of cation in solution. Nowhere in the book is 'complex ion' defined and surely an aqueous solution of the complex salt potassium sodium ferricyanide, $K_2NaFe(CN)_6$, contains two different cations. Further it is unwise to define reducing agents as electron donors because this term is normally used to describe molecules having free electron pairs.

Part II has a number of useful exercises on the various branches of titrimetric analysis and is headed 'Basic Titrimetric Exercises.' The use of 'basic' here as a synonym for 'fundamental' is unfortunate and misleading. On p. 39 two ways of labelling a solution are given, namely, 0·1036 N and 1·036 N/10, which inevitably will lead to errors in calculations. The blood-red colour produced when a thiocyanate is added to a ferric solution is wrongly attributed to the $[Fe(CNS)_6]^{3-}$ ion (p. 103).

Part III contains many useful miscellaneous exercises.

The book is well produced and the price modest.

ERNEST E. AYNSLEY

CALCULATIONS OF ANALYTICAL CHEMISTRY. SIXTH EDITION. L. F. Hamilton and S. G. Simpson. Pp. xii + 334. *New York: McGraw-Hill Book Company Inc.; London: McGraw-Hill Publishing Co. Ltd*, 1960. 46*s*.

American textbooks and examinations often reveal marked predilection for numerical problems and it is a common gibe that this is because numerical solutions lend themselves to marking by unqualified assistants or mechanical means. Be that as it may, it is certainly undeniable—and the fact has been stressed by successive examiners in Part II of the Grad. R.I.C. examination—that many of our advanced students at university level are incapable of carrying out correctly quite simple calculations on their own or other people's experimental data. In this country we ought certainly to put our house in order and devote more attention to this quite essential aspect of a scientist's training and the present volume affords ample instruction and a wealth of examples, at least as far as analytical chemistry is concerned.

The first chapter (14 pp.) deals with basic mathematical operations and the concept of standard deviation, the use of logarithms, the slide rule and nomographs. Then follow chapters on chemical equations (14 pp.), concentrations of solutions (6 pp.) including formal and molal solutions, an extensive study of equilibrium constants (41 pp.) and a section on redox potentials (11 pp.), which should be of special value as this topic is rather neglected in many English textbooks. The second part of the book deals with the chemical balance (7 pp.), calculations of gravimetric analysis (16 pp.) and calculations from reported percentage compositions. Part III on Volumetric Analysis (82 pp.) includes the calibration of apparatus, neutralization methods, redox titrations, precipitimetry, and a short section entitled complexiметry which quite inexplicably makes no reference to EDTA and its uses. Part IV (53 pp.) embraces calculations on various physical methods of analysis such as electrolysis, potentiometric, conductrimetric, amperometric and coulometric titrations, optical methods and gas-volumetric methods.

A section of 13 pages summarizing common analytical determinations for common elements and radicals provides background material, and the book concludes with over 100 problems on specific groups and analytical determinations of mixtures. Spot checks on several of the answers (pp. 303-308) revealed no errors. There are a number of useful tables and a satisfactory index. This will certainly be a valuable book for any teacher. It may prompt someone to that necessary reform in which confusion caused by the terms 'equivalent weight' and 'normal solution,' with all their attendant ambiguities, is avoided by a consistent use of *molarity*.

H. IRVING

INTRODUCTORY CHEMISTRY. Second Edition. O. W. Nitz. Pp. viii + 631. *Princeton: D. Van Nostrand Co. Inc.; London: D. Van Nostrand Co. Ltd*, 1961. 60*s*.

Since it first appeared five years ago this book has been reprinted three times and now a second edition has been published. Clearly, it has established itself in America as an introductory textbook for students who are not going to specialize in chemistry. This extensively revised second edition will, no doubt, further increase its popularity and usefulness.

The new edition appears in a much more attractive dust-cover and binding. The book is now printed on white instead of cream paper, and this has resulted in

a considerable improvement in the clarity of the print and the diagrams. The reproduction of the photographs is also very much better in this edition. These changes make the book easier to read and more pleasing to handle and use.

The subject matter has been reorganized and added to, some sections being completely rewritten. The result is a more logical and up-to-date introduction to the principles of chemistry in the first section of the book, which is particularly valuable. Among the new topics discussed are atomic orbitals, the electronic configurations of the elements, the relative sizes of atoms and ions, Pauling's electronegativity values, equilibrium constants, solubility products, the Brønsted-Lowry definition of acids and bases and oxidation potentials. Throughout there is a more extensive use of electronic formulae and many new photographs of molecular models are included. The chemistry of the elements has been extended by the inclusion of very brief descriptions of 10 additional elements. The introduction to organic chemistry has been expanded, as have the chapters on biochemical topics, which now include a section on vitamins.

In many ways this edition represents a considerably improved book and might well be considered to meet the requirements of the changing ideas about the earlier stages of the teaching of chemistry in schools as represented by the recently published syllabuses of the Science Masters' Association. The requirement it will not meet is price, which has been increased from 42*s.* to 60*s.*, presumably to pay for the extra 111 pages of the book.

A. G. CATCHPOLE

ORGANIC CHEMISTRY. B. J. Stokes. Pp. viii + 488. *London: Edward Arnold (Publishers) Ltd*, 1961. 20*s.*

This book aims at meeting the requirements of students taking G.C.E. 'A' and 'S' levels, and of those sitting university scholarship and entrance examinations. As well as providing a background for university work, it sets out to indicate the scope and significance of organic chemistry today to those who will not study the subject further. There are sections on important industrial groups of organic chemicals, such as drugs, dyestuffs and plastics, that relate the subject to everyday life.

The introductory section deals with atomic theory, molecular structure and organic analysis.

Parts 2 and 3 are concerned with aliphatic and aromatic compounds, respectively, classified by functional groups. Experimental details of the preparation and reactions of the most important compounds are included.

Part 4, 'Advanced Topics,' has a chapter on Further Aspects of Organic Chemistry, explaining aromatic substitution in terms of electronic effects and briefly mentioning topics such as free radicals, heterocyclic compounds and non-benzenoid aromatic compounds. There is a simple introduction to wave mechanics and hybridization of orbitals in the carbon atom, to explain the shapes of organic molecules in modern terms.

Selected examination questions appear at the ends of chapters, and appendixes give information on preparing laboratory reagents and on identifying unknown organic substances.

The book is well produced, readable and up to date. Its use of electronic explanations of some structures and reaction mechanisms is welcome, as it prevents organic chemistry from seeming a catalogue of facts, as it often can at this level. It is a pity that the ideas of electron orbitals and hybridization could only be introduced at the end of the book, as an earlier mention would help to explain shapes of molecules more easily. It would also make more understandable the author's references to σ- and π-bonds in the early chapters on olefins and acetylenes.

The only printer's error that was noticed was the omission of the N hydrogen from the structural formula of pyrrole on p. 452.

This new book deserves serious consideration by teachers of chemistry about to replace outworn or outdated sixth-form organic textbooks.

R. M. HAINES

INDUSTRIAL CHEMISTRY. W. Davey. Pp. 101. *London: Robert Hale Ltd*, 1961. 8*s.* 6*d.*

There are so many books on careers that it is sometimes difficult to justify the publication of yet another. This book, which is published as one of a series of 'Target Books for Careers' does, in fact, give a very good account of industrial chemistry whilst referring only briefly to careers and training in industry.

The main sections of the book describe in general terms the development of particular fields of industrial chemistry, such as the isolation of natural products on the large scale, the extraction of minerals and metals, the manufacture of fuels and fuel products, and the bulk production of plastics and polymers. Without imparting any real chemical knowledge, these chapters tell the reader a great deal about chemistry in modern life—precisely the type of general information that every pupil should acquire before leaving school. Unfortunately many school chemistry courses at the present time do not adequately cover these aspects of the subject, and therefore this book will be welcomed as a useful addition to the school library.

The penultimate chapter illustrates the work of chemists and chemical engineers by means of a hypothetical example—the production of a new drug—and also describes the various routes for training for a career in industrial chemistry. This chapter, written perhaps in a too avuncular style, is the weakest in the book and could easily confuse a potential trainee, if he has the patience to read through to the end. There is a short chapter on women in chemical industry which simply

but effectively reiterates the oft-heard cry that there are plenty of openings for women in control and development laboratories. Finally there are three appendixes, giving details of courses, colleges and institutions, and a list of publications. Each of these the reviewer found inaccurate, jumbled and out of date.

D. G. CHISMAN

NITRIC ACID: MANUFACTURE AND USES. F. D. Miles. Pp. ix + 75. *London: Oxford University Press, published under the auspices of Imperial Chemical Industries Ltd*; 1961. 9*s*. 6*d*.

In common with earlier books of this series, this work is well written and up to date. After outlining the historical development of the manufacture of nitric acid, the author describes the properties of nitric acid and of the oxides of nitrogen at some length. The physical chemistry of the various reactions used in the production of nitric acid from ammonia is discussed, and some indication is given of the specialized engineering required in the construction of a plant for this process. The production of 50–65 per cent nitric acid and of 95–99 per cent nitric acid is given detailed attention. Some of the present uses of nitric acid are described in the last chapter.

This book contains much information which is not found even in some of the recently published textbooks for schools and colleges. It is well illustrated, and is presented in such a manner as to appeal to many concerned with introductory courses on industrial chemistry.

A few printer's errors were noted.

B. E. DAWSON

INDUSTRIAL WATER TREATMENT PRACTICE. Edited by P. Hamer, J. Jackson and E. F. Thurston. Pp. xv + 514. *London: Butterworths, in association with Imperial Chemical Industries Ltd*, 1961. 95*s*.

Opponents of the capitalist system regard it as self-evident that 'big business' should be essentially selfish, jealously guarding technical 'know-how' and the lessons of their own experience, and taking as their motto the famous phrase 'I'm all right, Jack.' It must have astonished such persons when Imperial Chemical Industries Ltd stated in 1947 that it would be the company's policy to produce and publish a series of books designed to pass on to others the knowledge and skill embodied in its own internal manuals. I possess, often consult and work from, and have much profited by, the two volumes on statistics already published by I.C.I.; it is a pleasure to be able to report that the latest volume worthily upholds the high standard of its predecessors.

Few organizations can be in a better position than I.C.I. to produce a treatise on water treatment. Not only are they, directly or through their subsidiaries, suppliers of almost every kind of conditioning chemical; they are, as is stated in the preface, users of water to the tune of 5,000 million gallons evaporated yearly, and requiring about 3,000 tons of chemicals for its treatment. It is not surprising that the whole of the book shows evidence of familiarity with, and critical examination of, both theoretical publications and commercial apparatus and plant. Moreover, page after page contains observations based on unpublished investigations within the firm or on its own practice.

The first section of the book is devoted to water-softening processes, two chapters dealing with precipitation methods, one with ion exchange and one with evaporation. Then follow eight chapters on problems of boiler systems of all types, including two outstanding chapters on scales and deposits and the prevention of corrosion. Cooling-water systems, control of organic growths and clarification processes account for three more chapters, and there are then 86 pages of physico-chemical data, including comprehensive solubility data for many gases and solids.

I have read this book with great interest and edification. I am not competent to appraise in detail all that it contains; I can only say that where my knowledge and experience are equal to the task, the book seems to me to be admirable. The only query I would raise on a point of detail is whether it is realistic to give a table (p. 8) showing 'analyses of three waters used in industry' with the anions *exactly* equal to the cations when expressed in equivalents. I wonder how many mineral analyses of water are found in practice to give this exact equality? Moreover, the figure given for 'dissolved solids' is derived theoretically from the sum of the anions and cations, whereas every analyst knows that the result obtained in practice is almost invariably more (because of, *inter alia*, retention of water of crystallization).

Like the beauty-spot on an eighteenth-century woman's face, this minor flaw serves only to reveal the excellence of the rest. I recommend this book, combining as it does theory with practice so praiseworthily, to all chemists who have anything to do either with the treatment of industrial water or with its analysis, in the confident expectation that they will find within the volume answers to their problems worth many times the value of the money they have spent in acquiring it.

ERIC C. WOOD

SCIENTIFIC RUSSIAN. A TEXTBOOK FOR CLASSES AND SELF-STUDY. Second Edition. J. W. Perry. Pp. xxvi + 565. *New York: Interscience Publishers Inc.; London: Interscience Publishers Ltd*, 1961. 72*s*.

This new and attractive edition of an important work will be welcomed by English-speaking scientists who wish to learn Russian. The student who uses this book will be very gradually and carefully introduced to the Russian language by the use of a great number of Russian words derived from other languages. The

majority of these words are of an international scientific character and will consequently be recognizable in their Russian form as soon as the student is familiar with the alphabet. He will then be gently led through the complexities of Russian grammar, which are slowly but completely unfolded and amply illustrated by a great number of sentences and phrases.

At the end of each of the 40 lessons into which the book is divided is a reading exercise consisting of about 300 words of Russian prose (shorter passages are used in the early lessons). These exercises are very successfully graduated. Constructions and phrases familiar in Russian scientific literature are introduced from an early stage, and after each exercise there is a valuable set of notes explaining the difficult or interesting points in the passage. These notes are followed by a translation exercise, in which 10 fairly straightforward English sentences are required to be translated into Russian. This type of exercise undoubtedly helps the student to grasp and retain the grammar and vocabulary of the language.

A vocabulary of over 2,000 words is used in the exercises and examples, and given in a useful list at the end of the book. This provides an essential basis for reading Russian scientific work, particularly in chemistry and physics. The gradual introduction and effective repetition of words during the course of the book, together with the attention devoted to word formation and relationships between words, is very helpful to the English-speaking scientist's memory.

A student who worked through the book on his own would undoubtedly achieve very satisfying results, provided he devoted the considerable time required by the scope and detail of the course presented here. Teachers will find it particularly useful both as a class textbook and a source of valuable exercises.

P. L. WYVILL

THE EUCALYPTS: BOTANY, CULTIVATION, CHEMISTRY AND UTILIZATION. A. R. Penfold and J. L. Willis. Pp. xx + 551. *London: Leonard Hill (Books) Ltd; New York: Interscience Publishers Inc.*, 1961. 80*s*.

This book must be regarded primarily as a guide to the economic possibilities of the eucalypts. It is one of the World Crops Series, which is to include treatises on a large variety of other groups of plants and their products. So the reader looks here for the kind of information which would enable him to assess the suitability of introducing the eucalypts into other countries with a view to profitably utilizing their products. The authors have had extensive experience with these trees in Australia, and have collected and put in order a vast mass of information with this end in mind.

There is very little detailed chemistry to be found in the book. The principal constituents of the essential oils are enumerated and summarized, but no account is given of the methods by which they are isolated and characterized. Other chemical aspects are also dealt with very briefly. On the other hand, in keeping with the stated objective of the book, such matters of economic importance as the susceptibility of the various species of Eucalyptus to insect and fungus attack, the characteristics of the timbers, the methods of planting and propagation and so on are given as adequate treatment as space allows. One economic use of the eucalypts which may be new to some readers is as a source of honey. The matter is dealt with in some detail, and it has undoubted value for the bee-keeping industry in Australia. This aspect of Eucalyptus utilization would also be a factor of importance in the acclimatization of some of the species in other countries.

This is a valuable work for those interested in the commercial possibilities of the genus *Eucalyptus*. It will also meet the needs of those requiring an authoritative general survey of a genus which forms a very large section of Australian native vegetation. The text is well printed and illustrated.

J. C. EARL

ENCYCLOPAEDIC DICTIONARY OF PHYSICS. VOLUME I. A TO COMPENSATED BARS. Editor-in-Chief, J. Thewlis. Pp. xv + 800. *Oxford: Pergamon Press*, 1961. £80 per set.

Not since the appearance of the *Dictionary of Applied Physics*, edited by Sir Richard Glazebrook about 40 years ago, has an encyclopaedic dictionary of the subject been produced on the ambitious scale of the present work. With the enormous growth of physics and its penetration into almost all scientific fields, the task of documenting its contents alphabetically is a gigantic one, and has only been possible with a small army of consulting editors and contributors. How far their labours have been successful can now be judged by the appearance of this first volume. In addition to covering general, nuclear, solid-state, chemical, metal and vacuum physics, the relevant topics in mathematics, astronomy, geophysics, biophysics and so on are included in the scope of this work. Its purpose is to give an authoritative introductory account of any subject and to supply a key to literature where more information can be obtained. Much space is of course devoted to aspects of physical chemistry, and indeed the chemist will find it a quick reference to many topics in his own field as well as a guide to subjects with which he may be less familiar.

Some, no doubt, will not find this form of documentation of knowledge to their liking, and will prefer to use the index of specialized handbooks where the topics are developed in a continuous and coherent fashion. However, the appropriate book is not always immediately available, and the speed with which definitive information can be obtained from an encyclopaedia often

more than compensates for its limitation in other directions.

Finally, it should be said that in the main the scientific and literary standard of this volume is of the highest order, though it contains some trivial items which should have been eliminated in the editing. The whole encyclopaedia, when it is eventually completed, should prove to be of great value as a *vade mecum* in helping the specialist in one field to find his way about safely in another.

W. C. PRICE

THE ENCYCLOPEDIA OF MICROSCOPY. Edited by G. L. Clark. Pp. xiii + 693. *New York: Reinhold Publishing Corporation; London: Chapman & Hall Ltd*, 1961. 200*s*.

This, the most recent of a series of one-volume encyclopaedias presented by the Reinhold Publishing Corporation, inclines one to wonder what purpose these books are supposed to serve and for whom they are supposed to be written.

It is presumably the function of publications such as these to be instructive to the layman, to guide the expert into neighbouring fields, and to enable the layman and the expert to find quickly facts relevant to their own interests. If this is the intention then it cannot be said that the present volume meets with any measure of success. The 26 kinds of microscopy described are certainly arranged alphabetically, with subtitles also in alphabetical order, so that it is a simple matter to look up, for instance, the electron microscopy of kidney (13 pp.), particularly if the reader is live enough to spot that another 14 pages occur further on under the heading 'Pathology, Kidney'; but the lack of an index makes it impossible to discover interesting paragraphs such as those on the resolving power of electron microscopes under 'Colloids, Lyophobic' without reading the whole book. The numerous theoretical expositions which the expert would certainly not seek in such a volume are clearly aimed at the layman, but he will surely find them much too complex, particularly in those numerous places (*e.g.* pp. 503-506) where the absence of a diagram confuses even the semi-expert.

If, on the other hand, this volume is intended as an authoritative, internationally-representative pronouncement, as the preface implies, then it still falls far short. It is understandable that, with some notable exceptions which it would be invidious to mention, the authors are not recognized authorities, who are always busy on more major works; but this does not explain the conspicuous absence of well-known names from the bibliographies. Moreover, a book in which 47 authors are Americans, 16 English and with only 13 from Canada, Sweden, Switzerland, Holland, France, South Africa and Japan together (of which countries some at least can claim to be active in microscopy) can hardly be called international. Nor is it conceivable that all the universities in the world outside the United States are so inexperienced in this field that their contribution can be assessed by 10 articles (of which seven come from Oxford and Cambridge) when industry contributes 35 articles and American universities 20. The readers of this volume cannot but be struck by the lack of balance among the articles. It seems, for instance, odd to have devoted four-and-a-quarter pages to 'Leaf Surfaces'—on which very little has been done, with implications still obscure—and yet only one-and-a-quarter pages on 'Cell Walls' and a mere third of a page on 'Bacteria,' with their voluminous literature and not inconsiderable importance. Again, it is understandable that 242 of the 693 pages should be devoted to electron microscopy and 114 to X-ray microscopy (even if this seems generous in view of the present state of the art) but it cannot be conceded that the powers of the polarizing microscope are so limited, and the extensive literature so devoid of interest, as to demand only five pages with scattered references elsewhere.

These are, however, failings of the book as an encyclopaedia. If it can be regarded dispassionately as a series of separate articles then it can be said that the individual contributions are on the whole well-conceived, well-written, beautifully illustrated and with adequate—sometimes copious—bibliographical references to further reading. Some of the writing is naïve (*e.g.* p. 1, 'Foreign journals often carry detailed papers . . . which should not be overlooked . . .') or loose (*e.g.* p. 53, 'The crystal is said to have a positive sign of absorption when the darker color is "lengthwise" . . .'; p. 533, 'Electron microscopes of or over 50 Kv in potential') and there are some errors (*e.g.* 't' is included in error in equation 2 on p. 504), but equally many of the sections are well done, such as those on chemical microscopy, X-ray microscopy and, on the whole, that on electron microscopy, though throughout the choice of material is clearly dictated by the authors' own interests. This has led to some considerable repetition (the methods of specimen preparation for electron microscopy are discussed repeatedly) and there are notable gaps.

As a whole, the book gives a very readable, concise account of some of the outstanding achievements in microscopy, and it is a marked feature that throughout an eye is kept on future developments. It is beautifully presented and the innumerable photographic illustrations are superbly reproduced. The faults of the book lie chiefly in the severely restricted choice of topics forced upon the editor by the formidable task of exploring a field which is certainly far too enormous to be compressed within the pages of a single volume.

R. D. PRESTON

Institute Affairs

EXAMINATIONS, JANUARY, 1962

Graduate Membership, Part I.—An examination will be held on Monday and Tuesday, 8 and 9 January, 1962, in London, and elsewhere at the discretion of the Council.

The last date for the receipt of Application Forms was 9 October.

Entry forms will be sent as soon as they are ready to accepted candidates. **The last date for the return of Entry Forms will be Wednesday, 8 November, 1961.** No entry will be accepted if received after that date.

Graduate Membership, Part II.—The theoretical section of the examination—Part II(*a*)—will be held in London, and if required, in other centres, on Monday and Tuesday, 8 and 9 January, 1962.

The practical section of the examination—Part II(*b*)—will be held in London on Wednesday to Saturday, 10 to 13 January inclusive, and Tuesday to Friday, 16 to 19 January, 1962, inclusive.

Candidates will be asked to state their preference as to the centre for their theoretical papers, and the period for their practical examination, but it must be clearly understood that no guarantee can be given that their wishes will be met.

Last dates for application and for entry are the same as for the Graduate Membership Part I examination (*see* above).

NOMINATION AND ELECTION OF DISTRICT MEMBERS OF THE COUNCIL

Fellows and Associates are hereby notified that, for the election of District Members of the Council for Districts in Great Britain and Ireland, to serve from the close of the Annual General Meeting on 13 April, 1962, nominations should be received at the offices of the Institute **on or before Thursday, 30 November.**

Procedure for the nomination and election of District Members of the Council for Districts in Great Britain and Ireland, referred to in By-law 17(*c*), is prescribed by By-law 30 and by Regulations made thereunder by the Council (*see J.*, 1957, 639).

In accordance with By-law 30(3) a District Member of the Council is elected to serve for **one year,** but under the provisions of By-law 23(*c*) he is thereafter eligible for re-election year by year until he has served as such for **three successive years** (apart from any period of less than one year in filling a casual vacancy).

The Fellows whose names are given below are the present Members of the Council for the Districts indicated. Those whose names are printed in *italics* will have completed three successive years of service on the Council or have otherwise become ineligible for re-election under the provisions of the By-laws or of the Regulations made thereunder.

England

I *Walter Wilson*, PH.D., D.SC., A.R.C.S., D.I.C.

II *Frederick Denison Maurice Hocking*, M.SC., M.B., B.S., M.R.C.S., L.R.C.P., A.C.G.F.C., M.I.BIOL.

III Louis Hunter, PH.D., D.SC.

IV Reginald Langham Elliott, B.SC., PH.D., F.T.I., F.S.D.C.

V *Percy Noel Williams*, M.SC.

VI Frederick Cecil Hymas, M.SC.
Samuel Aaron Miller, M.A., B.SC., PH.D.

VII *Sidney John Fletcher*, B.SC., PH.D., D.L.C.

VIII Leslie Horton Williams Hallett, M.A., B.SC.

IX *Leonard Balmforth*, B.SC.

X Frank Henry Day, M.SC., PH.D.

XI *Richard Eric Parker*, B.SC., PH.D.

Wales

I Percival Francis Ellis, M.B.E., B.SC.

II William Rogie Angus, M.A., PH.D., D.SC.

Scotland

I *Mearns Bruce Watson*, B.SC., PH.D.

II Frank Bell, PH.D., D.SC., F.R.S.E.

III Patrick Dunbar Ritchie, B.SC., PH.D., F.P.I., M.I.CHEM.E., F.R.S.E.

Northern Ireland

William Ford Kirkpatrick, A.H.-W.C., F.I.C.I.

Republic of Ireland

Denis Crowley, M.SC., F.I.C.I.

Directory of Independent Consultants.—The Fourth Edition (1961) of the *Directory* is now available and can be supplied gratis to bona fide inquirers for consulting services in chemistry and related subjects.

It contains particulars of 156 practices, followed by a subject guide.

Entries in the present edition have been restricted to practices in Great Britain and Ireland that satisfy the following conditions:

(i) Effective control of the policy and operation of the practice is vested in one or more Fellows or Associates of the Royal Institute of Chemistry, and the provision of consulting services in chemistry and/or closely related subjects is the sole or predominant activity of those controlling

Principals and is an essential part of the business of the practice.

(ii) The practice is not part of, or subsidiary to, any other organization, and its sole or predominant business is the provision of independent consulting services.

It is thus provided that every practice listed in the Directory is fully independent and is controlled by Principals who are professionally qualified and able to accept responsibility for the exercise of scientific competence and personal integrity in conducting the work of the practice. These controlling Principals, being Fellows or Associates of the Institute, can be relied upon to maintain high standards of professional conduct in all their dealings. Moreover, they are committed to acceptance of the restraints imposed by the Institute on overt individual advertising of their practices in the U.K.

Library of the Chemical Society.—The Library will close at 7.30 p.m. on Friday, 22 December, and will re-open at 9.30 a.m. on Thursday, 28 December.

Meldola Medal Lecture.—Dr John Newton Bradley (Medallist for 1960) will give his lecture at 5.15 p.m. on Wednesday, 22 November, in the Main Lecture Theatre, Roderic Hill Building, Department of Chemical Engineering and Chemical Technology, Imperial College, Prince Consort Road, London, S.W.7.

MELDOLA AWARD FOR 1961

The **Meldola Medal** is the gift of the Society of Maccabaeans and is normally awarded annually. The next award will be made early in 1962 to the chemist who, being a British subject and **under 30 years of age at 31 December, 1961**, shows the most promise as indicated by his or her published chemical work brought to the notice of the Council of the Royal Institute of Chemistry before 31 December, 1961.

No restrictions are placed upon the kind of chemical work or the place in which it is conducted. The merits of the work may be brought to the notice of the Council, either by persons who desire to recommend the candidate or by the candidate himself, by letter addressed to **The President, The Royal Institute of Chemistry,** 30 Russell Square, London, W.C.1, the envelope being marked 'Meldola Medal.'

The letter should be accompanied by **six copies** of a short statement on the candidate's career (date of birth, education and experience, degrees and other qualifications, special awards, etc., with dates) and of a list of titles, with references, of papers or other works published by the candidate, independently or jointly. Candidates are also advised to forward one reprint of each published paper of which copies are available.

PERSONAL NOTES

News of Hon. Fellows

Lord Cohen of Birkenhead, as the new President of the National Society for Clean Air, took the chair at Brighton on 4-6 October at the Clean Air Conference.

Sir John Cockcroft, O.M., F.R.S., *Nobel Laureate*, has been elected president for 1962 of the British Association for the Advancement of Science. The Association's Annual Meeting for 1962 will be held in Manchester.

Societies and Institutions

Dr W. T. K. Braunholtz, O.B.E., *Fellow*, has been elected an honorary member of the Association Technique de l'Industrie du Gaz en France.

Dr D. C. Garratt, *Member of Council*, gave the Chairman's Address to the British Pharmaceutical Conference at Portsmouth on 17 September. His title was 'Analysis Analysed—A More Rational Approach to Pharmaceutical Control' (*see Chemist and Druggist*, 23 September, p. 330).

Society of Cosmetic Chemists.—At the A.G.M. of the Society of Cosmetic Chemists of Great Britain, held on 25 May, the following members were elected Officers: President, Dr H. W. Hibbott, *Associate*; Vice-President, Mr G. A. C. Pitt, *Fellow*; Hon. Editor, Mr A. Herzka, *Associate*.

Educational

Mr G. A. J. Carter, *Associate*, who retired last year from the Shell International Petroleum Co. Ltd after over 34 years' service, has taken up a part-time post as chemistry teacher at Ringwood Grammar School, Bournemouth.

Mr J. S. Clarke, *Associate*, has taken up the appointment of senior chemistry master at Alleyn's School. He was formerly chemistry master at Lancaster Royal Grammar School.

Dr J. A. W. Dalziel, *Fellow*, has been appointed reader in analytical and inorganic chemistry at Chelsea College of Science and Technology. He was formerly lecturer in inorganic and analytical chemistry at the Royal College of Science, London.

Mr D. H. D. Elias, *Associate*, of the Portsmouth College of Technology, has been appointed senior lecturer in organic chemistry in the department of chemistry and biology.

Mr J. W. Gailer, *Fellow*, formerly deputy director of education (technical) in Uganda, has been appointed adviser on technical education to the Federal Government of Nigeria, as from 8 September.

Mr S. McLintock, *Fellow*, head of the department of chemistry and metallurgy, Flintshire Technical College, has been appointed Vice-Principal of the College.

Dr G. F. Reynolds, *Fellow*, formerly a principal scientific officer, chemical inspectorate, War Office,

has been appointed reader in analytical chemistry at Loughborough College of Technology.

Mr W. V. Sherman, *Associate*, has been awarded a Fulbright Travelling Scholarship and will be spending one year as post-doctoral research associate at Brandeis University, Waltham, Mass., U.S.A.

Public and Industrial

Mr J. E. Adamson, *Fellow*, has recently obtained an appointment as chief chemist to the Union Glue and Gelatine Company Ltd, Cransley Works, London.

Mr Khalid Beg, *Associate*, who was recently appointed a scientific officer in the radiochemistry section, Pakistan Atomic Energy Commission Laboratories, Lahore, is proceeding to Chalk River, Canada, under the Colombo Plan fellowship scheme, for special advanced training.

Dr W. Blakey, *Associate*, joint managing director of British Industrial Plastics Ltd, has been appointed deputy chairman of the company.

Dr W. R. Boon, *Fellow*, research and development director of Plant Protection Ltd, has assumed responsibility for technical services work on the retirement of Dr E. Holmes (*see J.*, 342).

Mr G. W. J. Bradley, *Fellow*, who has been a member of council of the British Coke Research Association since its inception in 1944, has relinquished his membership of the council following his retirement from the industry.

Mr V. C. H. Brockwell, *Fellow*, has been appointed general sales manager of Glovers (Chemicals) Ltd. He was formerly southern area technical sales manager.

Mr E. R. Forshaw, *Associate*, formerly with Shell Chemical Co. Ltd, is now manager of the development department, Pure Chemicals Ltd.

Mr A. M. Freke, *Fellow*, has left the National Coal Board to take up a position as a principal scientific officer with the radiological protection division, Health and Safety Branch, U.K.A.E.A.

Mr N. A. Iliff, *Fellow*, managing director of Shell Chemical Company, has resigned from the board of Styrene Co-Polymers Ltd.

Mr E. K. G. James, *Fellow*, has been appointed to succeed Mr E. E. Haddon, *Fellow*, as director of chemical defence research and development, War Office.

Mr E. C. H. Lawrence, *Associate*, has been appointed superintendent of the R.N. Propellant Factory, Caerwent, Monmouthshire. He was formerly manager and deputy superintendent.

Mr A. C. Macdonald, *Fellow*, a director and production controller of Albion Motors Ltd, Glasgow, has been appointed general manager.

Mr P. L. McIlmoyle, *Associate*, has been appointed assistant manager in the purchasing department of Castrol Ltd. He was formerly a technical assistant.

Mr P. J. March, *Fellow*, has been appointed to the board of Styrene Co-Polymers Ltd in succession to Mr N. A. Iliff (*q.v.*).

Mr D. N. Marvin, *Associate*, has been appointed commercial director (home), Imperial Chemical Industries Ltd, Fibres Division.

Mr G. M. Power, *Associate*, formerly technical department manager, Imperial Chemical Industries Ltd, Wilton, has been appointed head of the technical department of the company's European Council, with effect from 11 September.

Dr K. Sellars, *Associate*, of S. C. Johnson & Son Ltd, has been appointed director of research and development.

Dr D. H. Sharp, *Fellow*, now with Fisons Ltd, has been appointed technical director, Federation of British Industries, as from 1 November.

Dr J. E. Stanworth, *Fellow*, has been appointed director of research, A.E.I. (Rugby) Ltd. He was formerly head of the materials and general physics division, research laboratory.

Mr Alan Fowler Williams, *Fellow*, has resigned his appointment as a scientist at the National Coal Board's Research Establishment, Cheltenham, and has joined the scientific staff of the laboratories of Esso Research Ltd, Abingdon.

Mr Leslie Harry Williams, *Fellow*, has been appointed a full-time member of the British Transport Commission, with special responsibility for commercial affairs.

Retirements

Mr Jack Harris, *Associate*, has retired from his position as second master at St Dunstan's College.

Dr J. Haslam, *Fellow*, chief analyst, Imperial Chemical Industries Ltd, Plastics Division, retired on 31 July, after 33 years' service. He will now be available at 22 Great North Road, Stanborough, Welwyn Garden City, for advisory work in connection with the training of analytical chemists, the equipping of analytical laboratories and the solution of general analytical problems.

Mr P. S. S. Krishnan, *Associate*, chief chemist, Central Revenues Control Laboratory, New Delhi, India, has retired.

Mr C. W. G. Martin, *Fellow*, has retired as head of the marketing laboratories division, Oil Products Development Division, Shell International Petroleum Co. Ltd, after nearly 41 years' service.

Mr C. V. Oliver, O.B.E., J.P., *Fellow*, has retired from Albert E. Reed & Co. Ltd. He will continue to be associated with the paper industry as President of the Employers' Federation of Papermakers and Boardmakers and with other trade associations.

Dr W. S. Patterson, *Fellow*, has retired from his post as reader in fuel science at the University of Durham.

Mr H. N. Read, *Fellow*, superintendent of the R.N. Propellant Factory, Caerwent, Monmouthshire, retired on 31 August after 38 years in the service of the Admiralty.

Section Activities

London Summer Visits

Chesterford Park Research Station.—A party of 26 members visited the Chesterford Park Research Station of Fisons Ltd on 18 July. Twelve members arrived early and were entertained to lunch by the company. After the arrival of the main party, the Research Director, Dr G. S. Hartley, described the scope of the Station's work. Synthesis and screening of potential new pesticides is carried out, and subsequent field investigation of promising products is conducted on the Station's extensive crop land. The behaviour of drops of pesticide solutions and suspensions under the conditions encountered during spraying is also being investigated, and analytical control of residual matter on crops after spraying is carried out.

The party divided into two groups to tour the Station. The methods used in the preliminary evaluation of new compounds as insecticides and nematocides were demonstrated, including methods to distinguish activity due to contact, or ingestive or fumigative action. Evaluation as both pre-emergent and post-emergent herbicides is conducted against crop species, giving more reproducible results than would be obtained with the actual related weed species. The plants are grown under conditions of controlled artificial lighting, with refrigeration to remove the excess heat generated.

The microanalytical and gas-chromatographic facilities were next visited. Equipment for the Unterzaucher direct oxygen determination, and for the very simple Schöniger combustion procedure, were amongst the apparatus shown in the former laboratory, while in the latter, applications of an argon chromatograph have led to investigation of electron-capture detection, particularly for halogen-containing compounds.

An apparatus producing streams of fine droplets was then used to demonstrate how the nature of the surface, including that of plant leaves, affected the adherence of droplets. Pea and bean leaves show markedly different behaviour towards such droplets, illustrating that some degree of killing selectivity may be obtained as a result of purely physical factors. Variations in droplet size and the surface tension of the liquid can cause a very sharp change from 'sticking' to 'bouncing' behaviour. The results obtained from such studies have aided in the formulation of spraying mixtures of consistent activity.

Finally, the party saw equipment for studying the evaporation of falling drops as occurs during spraying operations. Members of Fisons' staff answered many questions during the tours, and final queries were discussed with members of the senior staff over tea. The thanks of the party was expressed by Dr A. J. Duke. Arrangements for the visit were made by the Education Officer, Mr G. B. Thompson.

British Oxygen Company Ltd. On 26 July, a group of members visited the scientific division of the British Oxygen Company Ltd, at Deer Park Road, London. The party was welcomed by Dr L. C. Bannister who recalled the close ties between the division and the London Section. Dr Bannister then surveyed the many and varied undertakings of the company, including the separation of gases from air and the uses of these gases; the liquefaction of hydrogen and helium; the production of acetylene; chemicals from carbide; welding. The group then split into small parties, each under a senior member of staff.

The parties were taken through the analytical laboratories and had an opportunity to see instrumentation analysis being applied to gaseous mixtures; they were then introduced to the work being done on anaesthetics. It was fortunate that the tray efficiency rig assembly was being repaired, since this gave members an opportunity to see inside the apparatus. The production of liquid helium was also in progress, and this afforded considerable interest. Problems as to the nature and characteristics of an arc were explained and some demonstrations were given.

Semi-technical plants for metallurgical research were seen in operation and, where that was not possible, the processes were explained by the use of labelled diagrams and unique visual aids.

Among the many interesting processes were the hot-patching of furnaces; fume suppression; pre-refining in a tower; and small-scale steel processing.

At the conclusion of the visit, the party was entertained to tea. Mr W. C. A. Hards then thanked Dr Bannister and his staff for an interesting and enjoyable afternoon which had been made particularly successful by the instructive comments of the party guides.

Manchester and District

A series of visits has been paid by parties of members to the offices of the *Daily Express* in Manchester. These visits, which were held in the evening, have been so popular that they have had to be organized as three separate parties. In the telegraph and news room the collection and writing-up of news were explained. The teleprinters were in continuous operation and news messages were being received from various parts of the country. The working of the linotype machine was seen, followed by the correction of the page of type by the proof readers. The corrected plate was converted to a papiermâché positive, which, being flexible, allowed a half-cylinder plate of type to be cast. A cylinder of type on the printing machine was made with two of these half cylinders. After printing, the separate streams of paper corresponding to the various pages came together, were folded, cut and finally delivered to the despatching department. Members were able to see the Irish edition leaving the building

about 9.30 p.m. in time to catch the night boat from Heysham. The high degree of mechanization throughout the plant was impressive, and it was easy to forget the human part of the endeavour, which is so essential. The great trouble taken by the management to make these visits interesting was appreciated by all who took part.

Cape

Cavitation in Propellers. A joint meeting of the Cape Chemical and Technological Society, the South African Chemical Institute and the Section, in conjunction with the Royal Society of South Africa, was held at Electricity House Theatre, Cape Town, on 21 June. Members of the Institute of Mechanical Engineers and the Institute of Marine Engineers were also invited to attend. Commander W. J. Copenhagen, O.B.E., addressed the meeting on 'Cavitation in Manganese-Bronze Propellers and the Spinning Disc'.

Commander Copenhagen said that on the west coast of South Africa from Hout Bay to Walvis Bay there are approximately 180 large wooden fishing craft operating on the fishing grounds. An alarming feature is that a considerable number of their propellers suffer from a disease known as cavitation. Statistics are not available, but figures supplied by an engineering firm indicate that in a group of 10 fishing vessels the manganese-bronze propellers had a service life of 7 to 17 months. In some cases the damage is so extensive that new propellers have to be fitted, while in others extensive welding of the pits in the blades is necessary. Apart from the cost of maintenance of propellers, the loss of efficiency leads to an increase in fuel consumption. Propellers installed in fishing craft are of varying dimensions, and have diameters of 30 to 48 in, the cost being from R150 (£75) to R500 (£250) each. These operate at from 700 to 1,500 revolutions per minute.

It is not generally appreciated that the peripheral or tip speed of a 44-in diameter bronze propeller revolving at 800 revolutions per minute produces a peripheral speed of 106 miles per hour, while that of the edge of the 4-in boss on the same propeller is only 10 miles per hour. It is at the propeller tips that cavitation appears in the form of small honeycombed pits. With continued service the attack spreads along the edges of the blades. The balance of the propeller is now affected, leading to vibrational effect and increased turbulence.

Propeller cavitation has been studied by a considerable number of workers, and it is generally considered to be due to the mechanical removal of a protective surface film. This is caused by turbulence of the water assisted by minute, but nevertheless intensive, shocks due to bursting bubbles of entrained air. The removal of the surface film from the peripheral edges institutes an electrochemical cell. Cavitation may therefore be described as the damage due to the combined destructive effect of erosion and corrosion.

Commander Copenhagen went on to say that in the intensely practical atmosphere of a Naval dockyard and an operational aerodrome, it is essential to explain to others the basic principles of corrosion in extremely simple terms. Therefore, in his domain metallic corrosion is described as a four-component system composed of anodes, electrically connected to a cathode, an electrolyte and a flow of electricity.

For the purpose of investigating the electrical changes occurring at the peripheral edge or tips of propellers, an experimental manganese-bronze disc was constructed in which the outer rim was electrically insulated from the central portion. An electrical connection was carried through the metal from the rim to a hollow shaft connected to a slip ring. In this manner, the electrical changes taking place between the rim and the central portion could be studied. After immersing the disc for periods in sea water, it was found that when the disc was now revolved, electrical currents were produced and could be measured. It was noted that a correlation existed between speed of rotation and the magnitude of the electrical current generated. These currents are produced in the electrochemical cell 'bare metal' (or partly bare metal) at the rim and film-coated (patina) metal of the inner ring.

In order to safeguard the protective film on the peripheral edge of a service propeller, a special zinc anode was employed. The ordinary commercial-quality zinc anodes usually fitted have proved to be ineffective owing to the formation of a tightly adherent film of high electrical resistance. British Admiralty chemists have demonstrated that the addition of a small percentage of aluminium and silicon enables these zinc blocks to be uniformly attacked, thus producing a continuous flow of a protective current. Such special zinc anodes were placed on the underwater hull of a large fishing vessel operating from Walvis Bay in December, 1958. At an inspection during October, 1960, it was found that the propeller was in perfect condition, and that no evidence whatsoever of cavitation existed. A recent report intimated that this propeller continues to be protected.

Walvis Bay was chosen for the experiment as it is well known that propellers of wooden fishing vessels operating from that port suffer considerably from cavitation. This is due to the fact that the seawater in the bay as well as the coastal waters often contains an extremely aggressive dissolved gas, *i.e.* hydrogen sulphide. This gas is produced by vast quantities of dead plankton on the sea bottom, assisted by sulphate-reducing bacteria. This large-scale practical experiment was therefore conducted under extreme conditions, that is in a most aggressive environment.

Cathodic protection by means of zinc or magnesium blocks has been recommended and successfully applied

to propellers in ships operating overseas for several years, and the results obtained from the composite spinning disc have helped to explain why cathodic protection is effective. It is believed that a continuous thin film of hydrogen is formed at the surface of the propeller, and that this behaves as a cushion for collapsing bubbles.

It must be stated, however, that in the particular case of the protected propeller in service for nearly two years at Walvis Bay, the design may be such that a minimum of turbulence is produced on rotation. Nevertheless, there is no doubt whatsoever that cathodic protection is beneficial, although it may not be the final answer to prevent cavitation.

It is considered that by using special zinc anodes at a cost of under R4 (£2) per year, a very considerable saving of propeller metal and fuel, as well as maintenance costs, can be effected.

In conclusion, Commander Copenhagen thanked the South African Council for Scientific and Industrial Research for its interest and support in connection with this investigation.

After many questions had been asked, Professor E. Newbery proposed the vote of thanks.

DECCAN

Industrial Wastes. A joint meeting with the Biochemical Society, the Indian Institute of Science, and the Society of Biological Chemists, India, was held on 26 July at the Indian Institute of Science, Bangalore. Dr T. R. Bhaskaran, co-ordinating officer, public health engineering research unit, Indian Council of Medical Research, All-India Institute of Hygiene and Public Health, Calcutta, lectured on 'Treatment and Disposal of Industrial Wastes in India.' Dr S. C. Pillai presided.

After briefly considering the different types of gaseous, liquid and solid wastes from various industries and indicating the importance of their proper disposal, Dr Bhaskaran limited the scope of his lecture to the precautions or guiding principles to be followed in dealing with the whole question of industrial wastes, the general methods of treatment and the urgent problem of certain liquid wastes at some industrial centres in India.

The lecturer said that the art of treatment of waste begins within the factory itself. Good housekeeping in the process rooms, improvements in manufacturing processes and adoption of newer methods are useful in minimizing the waste problem. The re-use of the pollutional constituents within the factory and recovery of by-products is the next consideration in tackling the problem. If there is still a waste-disposal problem after adopting these measures, treatment of waste is necessary. The methods used for treatment are mechanical, chemical or biological, or a combination of these methods. These methods effect removal of suspended solids by screening and settling; oil and grease by flotation and skimming; colloidal matter by flocculation with chemicals and settling; and putrescible matter by biological aerobic and anaerobic processes. These methods have been used with varying degrees of success in tackling different industrial wastes. The extent of treatment required depends on facilities available in the locality for disposal of the treated effluent. No treatment is necessary in places where adequate dilution water is available, while in other localities complete treatment of waste may be necessary to render it to the same standard of purity as the original process water. Between these extremes there are many intermediate situations.

In recent years the disposal of industrial wastes has become a pressing problem, particularly in the States of Uttar Pradesh, Bihar, West Bengal and Bombay, where the wastes have caused serious river pollution and other insanitary conditions. The liquid wastes that present difficulties include those from sugar factories, distilleries, paper mills, textile mills, shellac factories, rice mills, coke oven plants and the chemical industry generally.

With the aid of lantern slides, Dr Bhaskaran then gave an account of the work done by the public health engineering research unit of the Indian Council of Medical Research during the last decade on the treatment and disposal of the wastes from sugar mills, lac factories and distilleries in the States of Uttar Pradesh, Bihar and West Bengal. The surveys were conducted for information on the nature and magnitude of the disposal problem, pilot-plant studies and suitable methods of treatment.

In conclusion, he stated that with the improvements in industrial processes and development of new industries, waste disposal presents a changing front and necessitates a long-range programme of research, requiring the services of specialists in the various fields of science and technology. Industry should recognize its responsibility in this matter and actively co-operate with the government and other agencies in solving the problems.

Dr Y. I. Shethna proposed the vote of thanks.

Sprays for Disease Control. On 28 July a meeting of the Section was held at the Indian Institute of Science, Bangalore. Dr K. Kalyan, development chemist, and Mr P. de Jong, technical manager, of Tata Fison (Private) Ltd, Bangalore, spoke on 'Development of Low-Volume Sprays for Disease Control in Plantation Crops'. Professor P. S. Sarma was in the Chair.

Dr Kalyan first traced the development of the important copper fungicides after the introduction of Bordeaux mixture, and examined the various attempts made to improve this fungicide. He then discussed the general problems of formulation. He explained the use and action of a suitable deflocculating agent in a suspension in which flocculation would normally

occur. Although stability is an important criterion, an emulsion should be capable of breaking down on reaching the target, or soon after, so that the active ingredient can readily attack the pathogen.

In comparing the various methods of application, Dr Kalyan pointed out that low-volume application is more economical than the conventional 'run-off' sprays. Special types of formulation are required for low-volume application, and an effective oil-bound copper has been developed for this purpose. Success depends upon the mode of application and the formulation.

Mr de Jong then spoke on the practical aspects of fungicide application to plantation crops. He discussed the problem of a fungus of *Phytophthora,* which causes an abnormal leaf fall of *Hevea* rubber, and reviewed the development of the plantation rubber industry and the appearance and spread of this disease in South-East Asia. He next outlined early investigations in the use of Bordeaux mixture for the control of this fungus and dealt with the progress made in the application of fungicides to rubber.

Finally, he commented upon the use of alternative copper fungicidal formulations as dusts or oil-based sprays, leading to the current large-scale trials with oil-based copper fungicides applied by aircraft to large areas of rubber plantations in South India.

The latter part of the talk was illustrated by a colour film showing aerial spraying of *Hevea* rubber.

Dr S. C. Pillai proposed the vote of thanks.

EASTERN INDIA

Effect of Substituents on the Course of Dieckmann Cyclization. On 5 July at a joint meeting with the Institution of Chemists (India) held at the Central Food Laboratory (Calcutta), presided over by Mr S. P. Sen, Professor R. N. Chakravarti, head of the department of chemistry, School of Tropical Medicine, Calcutta, gave a lecture on the 'Effect of Substituents on the Course of Dieckmann Cyclization'. Professor Chakravarti presented an account of his long experiences on Dieckmann cyclization of unsymmetrical polycarboxylic esters having possibilities for formation of two or more isomeric keto-esters. Such cyclizations were carried out by various workers, including the lecturer, in connection with synthetic work on sex hormones, bile acids and terpenes. In some instances, erroneous conclusions were drawn regarding the structures of the cyclized products. The position was clarified properly by the lecturer by unambiguous methods. On the basis of the results obtained in the large number of cases cited, the following useful conclusions were drawn:

(i) The action of sodium on the ester of a β-alkyl derivative of adipic or pimelic acid, having two alternatives for cyclization, may be expected to lead to a ketonic ester in which the reactive methylene group nearer to the alkyl group remains unaffected by preference. The other isomer, in such a case, if produced at all, can only be in much smaller amount;

(ii) With a β-carbethoxy adipic or pimelic ester, having two alternatives for cyclization, the product of sodium condensation usually leads to a mixture of the two isomeric keto-esters in which the product formed by interaction of the α-methylene group with the carbethoxy group at the other end of the chain predominates;

(iii) With the ester of a β-alkyl adipic or pimelic acid, in which the α-methylene group is the only methylene group present in the molecule adjacent to a carbethoxy group and suitable for the cyclization, the sodium condensation proceeds smoothly in spite of the deactivating influence of the alkyl group;

(iv) The deactivating influence of the alkyl group on the adjacent methylene group appears to be due to its strong electron-releasing properties;

(v) As the effect of deactivation of a methylene group by an adjacent methyl group is much more pronounced than the activating influence of a carbethoxy group in a similar position, it is inferred that quantitatively the positive or electron-releasing character of a methyl group is much greater than the negative or electron-accepting character of a carbethoxy group.

The Chairman proposed the vote of thanks.

WESTERN INDIA

Activation Analysis. At a meeting held on 3 July, Professor B. C. Haldar lectured on 'Activation Analysis.' Dr H. S. Mahal was in the Chair. Professor Haldar explained how in activation analysis one or more radioisotopes of the element to be estimated are produced by irradiating a weighed sample with nuclear projectiles, the radioactivity then being measured with a Geiger-Muller or scintillation counter to determine the amount of the element in the sample being analysed. Decay measurements and an analysis of the energies of the radiation being emitted are used to complete the measurement. Professor Haldar indicated that thermal neutron activation is the most widely-used technique. This is due to the availability of high flux of thermal neutrons in a reactor and to the high reaction probability of thermal neutrons with a large number of elements. Activation analysis has been used to estimate quantities of halides in zinc sulphide, phosphorus, sub-microgram amounts of copper and arsenic in silicon, germanium used in semi-conductors, and trace impurities in super-pure materials required in nuclear technology. He explained further the specificity of activation analytical methods, and mentioned their applicability to mixtures of complex composition without trace contaminants and reagent blank difficulties.

News and Notes

COURSES AND FELLOWSHIPS

Chemical Education.—A special course of 6 lectures on 'The Chemical Bond in Chemical Education' has been arranged for 3 and 4 November by the department of chemistry and biology, The Harris College, Preston; the course organizer is Dr J. J. Betts. Lectures will be given by Dr G. W. Fowles, Professor R. S. Nyholm, F.R.S., Dr J. Lewis, Dr J. H. Ridd, Professor C. C. Addison and Mr M. G. Brown.

Forms of application may be obtained from the head of the department at The Harris College, Corporation Street, Preston. The course fee is £1 10*s*. and there are additional charges for meals.

Harkness Fellowships.—Thirty Harkness Fellowships of the Commonwealth Fund are offered for 1962 to British subjects holding degrees of U.K. universities or equivalent professional qualifications. The tenure of the Fellowships is from 12 to 21 months in the United States. Candidates should be between 21 and 32 years of age. The closing date for applications is 15 November. Further information may be obtained from the Warden, Harkness House, 38 Upper Brook Street, London, W.1.

Safety in the Plastics Industry.—A two-day course for supervisors and charge hands will be held on 5-6 December at the Industrial Safety Training Centre, Birmingham. This course was suggested by the Joint Education and Training Committee of the Plastics Institute and the British Plastics Federation. Further particulars may be obtained from the Secretary of the Institute or from the Director, Birmingham and District Industrial Safety Group, 22 Summer Road, Acocks Green, Birmingham, 27.

Short Courses.—Details of short advanced courses in science and technology, to be held in the session 1961-62, are contained in the annual publications of the various Regional Advisory Councils. Bulletins that have been received so far are: *Bulletin of Special Courses in Higher Technology*, London and Home Counties Regional Advisory Council for Technological Education, Tavistock House South, Tavistock Square, London, W.C.1 (Part I: Autumn Term, 3*s*. 6*d*.); *Short Advanced Courses in Higher Technology*, West Midlands Advisory Council for Further Education, 161 Corporation Street, Birmingham, 4 (gratis); *Bulletin of Advanced and Special Courses*, Regional Advisory Council for the Organization of Further Education in the East Midlands, 12 King John's Chambers, Bridlesmith Gate, Nottingham (1*s*. post free); *Specialized and Advanced Short Courses for Scientists, Technologists and Executives*, Yorkshire Council for Further Education, 52 Upper Basinghall Street, Leeds, 1 (3*s*.); *Special Advanced Courses*, Northern Advisory Council for Further Education, 5 Grosvenor Villas, Grosvenor Road, Newcastle, 2 (gratis).

MEETINGS AND CONFERENCES

Ciba Foundation Annual Lecture. The 13th Annual Lecture on 'Synthetic macromolecules as protein models' will be delivered by Professor E. Katchalski of the Weizmann Institute, Rehovoth, on 20 November. Owing to major reconstructions, the Foundation is temporarily closed for meetings, and this lecture will take place at the Royal Institute of British Architects, 66 Portland Place, London, W.1.

Clean Air Conference.—The 28th Conference of the National Society for Clean Air was held at Brighton on 4-6 October, the Chairman being their new President, Lord Cohen of Birkenhead. The Conference was opened by the Parliamentary Secretary to the Ministry of Power, Mr John George, C.B.E. Through the interest and co-operation of Pfizer Ltd, a transatlantic telephone discussion was arranged between a panel under the chairmanship of Sir Hugh Beaver at Brighton and a panel in New York. At another session officers of the Warren Spring Laboratory reported on the new National Survey on Air Pollution. A large part of the time available was devoted to studying the working of the Clean Air Act.

The Exhibition at the Corn Exchange was supported with exhibits from government departments, national research and industrial associations and private firms. Local secondary school children were invited to visit the Exhibition and enter a competition for an essay in the form of a newspaper report upon it.

The Colour Group.—The next Science meeting of the Group will be held at 3 p.m. on 3 November, at Burlington House, and will take the form of a joint meeting with the Society of Dyers and Colourists; Mr K. McLaren of Imperial Chemical Industries Ltd will talk on 'A Daylight Illuminant.'

Engineering with Plastics.—A conference on 'Engineering with Plastics' will be held on 31 October and 1 November at the Institution of Electrical Engineers, Savoy Place, London, W.C.2. Topics will include reinforced plastics, plastics in chemical engineering and an open forum. Programmes and registration forms may be obtained from the Plastics Institute, 6 Mandeville Place, London, W.1.

Imperial College Colloquia.—The Department of Chemical Engineering and Chemical Technology is again holding a series of Combustion Research Colloquia, details of which can be obtained from Dr J. H. Burgoyne at the College. Visitors are welcome to attend these colloquia without formality.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

The 123rd Annual Meeting was held in Norwich from 30 August to 6 September under the Presidency of Sir Wilfred Le Gros Clark, F.R.S. The President of the Chemistry Section, Professor R. G. W. Norrish, F.R.S., in his Address entitled 'Chemistry and Spectroscopy,' reviewed the development of the spectroscope since its invention 100 years ago and the importance of spectroscopy to the chemist today. In particular, he outlined the importance of absorption and emission spectroscopy in the study of gaseous reactions and the development of flash photolysis as a technique for studying such reactions. Most of the subsequent lectures to the Chemistry Section were devoted to the general theme of chemistry and spectroscopy. Professor R. A. Morton, F.R.S., delivered a lecture entitled 'Spectroscopy as a biochemical tool'; Dr N. Sheppard spoke on 'Chemical studies in the infra-red'; Mr R. A. C. Isbell on 'Analytical and industrial applications of spectroscopy'; Dr T. M. Sugden on 'Molecular structure and reactivity as revealed by microwave and radio-frequency spectroscopy; and Dr A. B. Callear on 'Absorption and emission spectroscopy of explosive reactions with special reference to knock and anti-knock in the internal combustion engine.'

The training of industrial food scientists and technologists in the U.K. was considered at the final session of the Chemistry Section, the discussion being introduced by Sir Herbert Broadley, K.B.E. Contributions were also read by Dr J. S. Mounfield, Principal of the National College of Food Technology, Professor J. Hawthorn, Professor of Food Science, Royal College of Science and Technology, Glasgow, and Dr J. W. Corran, chief chemist, J. & J. Colman Ltd. This discussion will, it is hoped, be reported more fully in a future issue.

Sir William Slater, K.B.E., F.R.S., was this year's President of the Agriculture Section; his Address was entitled 'The Revolution in Agriculture.'

Among the various excursions organized by the Chemistry Section were visits to two Norwich industries —John Mackintosh and Sons Ltd and J. & J. Colman Ltd. There were also many general excursions, as well as a programme of scientific films and social events, including a reception in the Castle by the Lord Mayor and City Council of Norwich and garden parties given by the Lord Bishop of Norwich, the Lord Lieutenant of Norfolk and the Governors of Norwich City College and Art School.

An interesting feature at this year's B.A. meeting was a demonstration of the Eidophor large-screen colour television system, which was used to relay the Presidential Address to an overflow meeting as well as to show three scientific programmes.

A special programme for young people in the Norwich area was arranged in co-operation with the Schools Advisory Committee and the Local Committee of the British Association. This included a 'Science in Schools' Exhibition, a 'Brains Trust' under the chairmanship of Dr W. E. Swinton and a series of illustrated lectures.

D. G. C.

Sir William Slater, President of the Agriculture Section, with (*right*) Professor R. G. W. Norrish, President of the Chemistry Section

CORRESPONDENCE

Reporting of Results

Sir,—At regular intervals discussions on 'precision' and 'accuracy' crop up in the chemical journals. These are of special importance to analytical chemists and your correspondent B. J. Walby has done a good service by calling attention to the action of the A.C.S. in defining 'accuracy' in terms of 'error.' This note is to reinforce Mr Walby's contention by recording that the word 'error' has been persistently condemned by the Commission on Nomenclature of the I.U.P.A.C., and, although American interests have been fully represented, the word 'error' has not been introduced into any definitions which have been discussed or approved by that body.

The writer examined some hundreds of methods of expression of the precision and accuracy of test results as given in one month's issue of various chemical abstracts and journals and reported the results in a paper given in Lisbon in 1956 (*Actas do Congresso* Vol. III). What was evident was that chemists used 'error' and similar terms according to their own inclinations and in most instances it would have been necessary to go back to the original work to find what exactly was meant. The A.C.S. no doubt noted that a large number of chemists used the term 'error' when no question of systematic bias arose and, to resolve the confusion, recommended 'error' to be consistently used to refer to what we should call 'systematic bias.' Most chemists nowadays have some knowledge of statistics and are accustomed to associate 'error' with precision

or 'scatter,' and it is a pity that the A.C.S. has gone against the trend. Moreover no chemist wishes to imply his method is erroneous by ascribing a 'mean error' to it.

It is hardly likely that this recommendation will be reversed until a large number of people die off, for, as Max Planck pointed out many years ago, this is the one way different ideas come to be accepted by the new generation of workers.

The best recommendation which can be made is that chemists on this side of the Atlantic use the term 'systematic bias' and put 'mean error' afterwards in brackets so as to tie up with A.C.S. practice. In the discussion on 'precision' and 'accuracy' in the July number of the A.S.T.M. *Bulletin* this device was adopted, for in one place it states 'Bias (or systematic error).'

Your correspondent pointed out the reason why there is so much tedious and acrimonious argument when these terms are discussed. It is impossible to calculate from a few test results 'a systematic bias due to inherent faults of the *technique* as well as that possible "stretch" or deviation due to random errors of the *analyst*. It cannot be done.' It comes as a surprise to an analytical chemist that he can give only the confidence limits of a series of test results so long as prior work has established a valid estimate of 'precision.'

Again it is not emphasized in the A.C.S. recommendation that $\bar{x}$ in the definition must refer to a long series of test results such that $\bar{x}$ is in fact in the centre of the distribution. Otherwise the 'mean error' as defined is not a valid estimate of the accuracy of the analytical method.

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THE MOLE AND FORMULAE

SIR,—A reply to Mr D. B. V. Parker[1] demands an examination of the relationships between molar masses and formulae. As I will be giving a full account of this elsewhere[2] it is sufficient to say that chemical analysis and molar mass determination can lead to the evaluation of one or more of $M_{\mathscr{E}}$, $M_{\mathscr{E}}$, and $M_{\mathscr{F}}$ which are the molar masses of a compound corresponding, respectively, to its *chemical formula* $\mathscr{E}$, its *empirical formula* $\mathscr{E}$, and its 'equivalent' or *functional formula* $\mathscr{F}$. In the case of ionic compounds $M_{\mathscr{E}}$ is almost always used. In the case of polymers $M_{\mathscr{F}}$ is used because there may be no means of knowing $\mathscr{E}$ and $M_{\mathscr{E}}$ and then it is useful to be able to refer to the molar mass of $\mathscr{F}$ (= RX) as the mass associated with one mole of a functional group X. I hope that the preceding sentence convinces Mr Parker that my intention is to rid the teaching of chemistry of some unnecessary and inaccurate words, like 'equivalent' and 'molecular weight,' but not to rid it of the quantities these numbers supposedly represent. He apparently believes that 'equivalents' have no connexion with formulae, for he writes: 'If we are to dispense with the concept of equivalents in chemistry, it is necessary to know (or to agree upon) the chemical formulae of compounds.'[1] On the contrary, if we are *not* to dispense with the concept of 'equivalent' it is necessary to know (or to agree upon) the chemical formulae of compounds, and it is because knowledge of an 'equivalent formula' is necessary, in order that ambiguity may be avoided, in stating 'normality,' for example, that it is shown to be superfluous.[3]

Finally, I ask Mr Parker to apply his valid reasoning (with its false premises: '. . . The urge to eliminate equivalents comes largely from those . . . for whom "molecular weight" has no great significance,'[1]) to polymer chemists, for whom also 'molecular weight' has no great significance because it is often unknown. The urge to eliminate 'equivalent' and many other similar words[4] actually comes from teachers and examiners who, as Miss M. M. Haslam says,[5] wish to sweep away this confusing historical lumber and replace it by usage that is far more efficient and economical.

I would like to make a correction to my previous letter[6]. The sentence following equation (7) should read: 'Here $n = w/M$ is the molar (or mole) amount. . . .'

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2. G. N. Copley, 'The Mole and the Molecule. Part III: The Determination of Molar Masses', *Sch. Sci. Rev.*, 1962, **43** (in the press).
3. G. N. Copley, *J.*, 251.
4. G. N. Copley, 'The Mole in Quantitative Chemistry,' *J. chem. Educ.*, 1961, **38** (in the press).
5. M. M. Haslam, *J.*, 318.
6. G. N. Copley, *J.*, 317.

GRAMS OR GRAMMES

SIR,—To my old friend Mr F. C. Bullock let me say that I was primarily pleading for 'gram' instead of 'gramme' as the printed word. I am indeed almost moved to repentance at the thought of the straits to which he is reduced by his staff's cacography, but I find his cure worse than the disease. The thing to do, I suggest, for us both is to go all out for something of which we both are in favour, which is the final and utter elimination of grains, minims, ounces, drachms (but not drams) and scruples, except the moral and scientific ones we doubtless both entertain.

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